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ABSTRACT

This curriculum guide contains teacher and student materials for a course on outboard-engine boat systems for power product equipment technician occupations. The course contains the following three units of instruction: (1) Orientation to Outboard-Engine Boat Systems and Rigging; (2) Trailers and Safe Towing and Boat Operation; and (3) Seasonal Procedures. Each unit in the teacher edition includes some or all of the following components: suggested activities, answers to assignment sheets, written test with answers, unit evaluation form, transparency masters, and worksheet masters. In addition, the teacher edition also includes a competency profile, an instructional and task analysis, academic and workplace skill classifications and definitions, and a list of related academic and workplace skills. All of the unit components focus on measurable and observable learning outcomes. Each unit in the student edition includes some or all of the following components: objective sheet, information sheet, student supplements, assignment sheets, and job sheets. (KC)

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# Power Product Equipment Technician:

# Outboard-Engine Boat Systems

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# *Outboard-Engine Boat Systems*

Teacher Edition

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# Foreword

*Power Product Equipment Technician: Outboard-Engine Boat Systems* and *Power Product Equipment Technician: Outboard-Engine Systems and Service* are two companion publications in a series of new publications developed to replace MAVCC's previous small-engine series.

Three publications in the new *Power Product Equipment Technician* series have been developed to replace the core publication for MAVCC's previous small-engine series.

- The first publication, *Theory and Principles of Engine Operation,* is divided into two sections: Section A, "Orientation," and Section B, "Basic Engine Theory and Operation." Section A covers basic workplace safety and first aid, common hand tools, common fasteners, and related math and measuring. Section B addresses reference materials; basic engine principles; engine design and identification; engine operation; and parts management, inventory control, and service orders.

- The second publication, *Engine Systems and Service,* is also divided into two sections: Section A, "Engine Systems," and Section B, "Engine Overhaul." Section A covers lubrication systems, cooling systems, fuel systems, governor systems, basic electrical principles, ignition systems, starting systems, charging systems, and exhaust systems. Section B addresses engine overhaul, troubleshooting, and failure analysis.

- *Equipment Systems,* the third publication, consists of seven units that cover principles of power transmission, mechanical drive systems, principles of fluid power, hydraulic and pneumatic drive systems, wheel and brake systems, chassis and steering systems, and chassis electrical systems.

Other publications have been developed as spin-off books from the three new core publications. These spin-off publications include *Lawn and Garden Equipment, Construction Equipment,* and the two companion publications *Outboard-Engine Systems and Service* and *Outboard-Engine Boat Systems.*

- *Lawn and Garden Equipment* contains an introduction to lawn and garden equipment, a unit on light-duty lawn and garden equipment (walk-behind lawn mowers, edgers, trimmers, dethatchers, blowers, hedge clippers, snow blowers, and pressure washers), a unit on heavy-duty lawn and garden equipment (garden tractors, riding lawn mowers, tillers, log splitters, and shredders), and a unit on chain saws.

- *Construction Equipment* contains three units: a unit on concrete equipment (powered concrete mixers, tampers, vibrators, floats, trowels, and screeds), a unit on water pumps and air compressors, and a unit on alternators, generators, and welding equipment.

- *Outboard-Engine Systems and Service* contains four units: a unit on outboard-engine design and identification, a unit on operation and service of engine-support systems, a unit on the operation and service of power-output systems, and a unit on the operation and service of control and safety systems. This publication, *Outboard-Engine Boat Systems*, contains three units: an orientation to outboard-engine boat systems and rigging, a unit on trailers and safe towing and boat operation, and a unit on seasonal procedures.

These new instructional materials reflect the changes that have occurred in the industry as a result of emerging technology and the demand for more highly skilled workers. The growing need for entry-level workers to be able to read and interpret information provided in manufacturers' service manuals has prompted us to include student supplements and assignment sheets that teach students how to use reference materials and to create job sheets with worksheets that require students to obtain specific information from a related service manual before completing a specific task.

# Foreword

Today's workers also need a stronger foundation in theoretical concepts and principles to help them better understand how engine systems and equipment components interrelate, and the information sheets and student supplements in the student edition have been designed to help provide that foundation.

The success of this publication is due in large part to the capabilities of the personnel who worked with its development. Appreciation is extended to them for their valuable contributions to the publication.

These instructional materials are designed for student use and to assist teachers in organizing and improving instruction. These instructional materials are based on the curriculum-alignment concept of first stating the objectives (objective sheet), developing instructional strategies for teaching to those objectives (information, assignment, and job sheets), and assessing to those same objectives (written test—a criterion-referenced evaluation instrument).

Every effort has been made to make these materials basic, readable, and by all means, usable. However, as with all of MAVCC's instructional materials, teachers must localize and personalize these materials to meet their community, classroom/laboratory, and individual student's situation. Teachers are encouraged to supplement the instructional materials and to develop strategies for motivating their students.

Special attention should be given to the matrix identifying basic academic skills being reinforced in these instructional materials as well as the suggestions on ways to increase reinforcement of academic and workplace skills. By reinforcing these skills, the instructor should assist students in improving their employability skills.

As you use these instructional materials, we hope that you will find that they contribute to the quality of your program. If any problems occur or if you have any suggestions for improvement of the materials, please call or write us.

Jim Fliehler, Chair
Board of Directors
Multistate Academic and
Vocational Curriculum Consortium, Inc.

Clark R. Harris
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# Acknowledgments

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The contents of this publication were planned and reviewed by the following members of the Multistate Academic and Vocational Curriculum Consortium development committee:

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Appreciation is also extended to Nancy Hilley for providing the major portion of the artwork used within this publication and to Mercury Marine, Fond du Lac, Wisconsin, for providing the artwork used on the covers of the student and teacher editions of this publication.

## Use of Introductory Materials

Introductory materials are included in the teacher edition only and contain useful information to assist administrators and teachers in planning for instruction.

In addition to the general information—such as the table of contents, foreword, and acknowledgments page—information is included on the following:

1. **Use of this publication**—Explains the components of a unit of instruction and how they should be used as part of the teaching/learning process.
2. **Competency profile**—Provides a record of student performance for each task included in a unit of instruction. This profile becomes a part of the student's permanent records and should be utilized when directing the student toward employment opportunities.
3. **Instructional/task analysis**—Provides a quick review of the contents of the publication; identifies cognitive (knowledge) skills and psychomotor (doing) skills addressed in each unit of instruction.
4. **Academic and workplace skill classifications and definitions**—Defines the basic-skill classifications used by MAVCC. Skill areas reflected by skill groups, subskills, and descriptions have been identified using *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.
5. **Related academic and workplace skills list**—Classifies unit tasks (assignment sheets and job sheets) according to related academic and workplace skills being reinforced.

As you use these materials, it is hoped that they will provide useful information to meet a variety of needs.

## Use of This Publication

### Instructional units

*Power Product Equipment Technician: Outboard-Engine Boat Systems* contains three units of instruction:

- Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging
- Unit 2: Trailers and Safe Towing and Boat Operation
- Unit 3: Seasonal Procedures

Each instructional unit in a student edition includes some or all of the following components: objective sheet, information sheet, student supplements, assignment sheets, and job sheets.

Each section in this teacher edition includes some or all of the following components for each of the three units of instruction: suggested activities, answers to assignment sheets, answers to written test, written test, unit evaluation form, transparency masters, and worksheet masters.

All of the unit components focus on measurable and observable learning outcomes. Teachers are encouraged to supplement, personalize, localize, and motivate with these materials in order to develop a complete teaching/learning process.

Units of instruction are designed for use in more than one lesson or class period of instruction. Careful study of each unit of instruction by the teacher will help to determine the following:

- Amount of materials that can be covered in each class period.
- Skills that must be demonstrated.
- Amount of class time needed for teacher demonstrations.
- Amount of time needed for student practice.
- Supplementary materials, including print and nonprint media and equipment and supplies, that must be ordered.
- Resource people who must be contacted.

### Student-edition components

It is a challenge to keep students motivated. Instructors should supplement the student-edition components by providing the "why," personal experiences, and current information. Prepare for each unit by deciding how each component can best be taught. Allow students to become involved in preparing and planning their teaching/learning experiences.

**Objective sheet.** Each unit of instruction is based on performance objectives that state the goals for successful completion of the course. These performance objectives are stated in two forms: unit objectives, which state the expected performance of each student after completion of the unit of instruction, and specific objectives, which state what the student must do to reach the unit objective.

The objectives should be stressed throughout the teaching/learning process. This will help answer any questions concerning performance requirements for each instructional unit. The objectives can also help determine teaching strategies and instructional methods. Teachers should prepare for each unit by deciding how each objective can best be taught.

## Use of This Publication

Teachers should feel free to modify, delete, or add objectives in order to meet the needs of the students and community. When objectives are added, the teacher should remember to supply the needed information-sheet, assignment-sheet, job-sheet, and written-test items.

**Information sheet.** The information sheet provides the content essential for meeting the cognitive (knowledge) objectives of the unit. Teachers will find that the information sheet serves as an excellent guide for presenting background knowledge necessary to develop the skills specified in the unit objective. Students should read the information sheet before the information is discussed in class. Space is provided in margins for students and teachers to add notes that supplement, localize, personalize, or provide information for the teaching of each objective.

**Student supplements.** The information presented in a student supplement may consist of tables, charts, written information, forms, or other information students will need in order to complete one or more of the assignment and/or job sheets. Students are not directly tested over the information presented in a supplement; however, their ability to apply this information is evaluated in the completion of assignment and/or job sheets.

**Assignment sheets.** Assignment sheets provide students with pencil-and-paper activities that give students the opportunity to make practical application of the knowledge in the information sheet and student supplements. Criteria are provided to objectively evaluate student performance.

**Job sheets.** Job sheets are an important segment of each unit; they give the instructor direction as to the psychomotor skills to be taught and allow both the student and instructor to check student progress toward the accomplishment of those skills. The worksheet included in each job sheet provides criteria to allow the instructor to objectively evaluate student performance of a particular psychomotor skill. The instructor should discuss the equipment and materials to be used—emphasizing the specific equipment and materials available in the classroom and/or laboratory—and demonstrate the job-sheet procedure before having students practice the psychomotor skill.

### Teacher-edition components

**Suggested activities.** The suggested activities assist teachers during the preparation stage of the teaching/learning process by providing an instructional plan, teaching suggestions, and a list of supplemental resources. Ways to integrate academic and workplace skills have been included in the teaching suggestions, and skill areas have been noted in bold. The teacher should read the suggested activities before teaching a unit and decide how each objective can best be taught. Time should also be allowed to obtain supplemental materials, prepare audiovisual materials, and contact outside resources. Duties of the teacher will vary according to the particular unit.

References used in the development of each unit are listed in the suggested-activities section along with suggested supplemental resources that may be used to teach the unit. These materials can be used by the teacher to supplement her or his knowledge of the subject area or to help students with particular interests or objectives in the area covered.

**Assignment-sheet and written-test answers.** Assignment-sheet answers and written-test answers are designed to assist the teacher in evaluating student performances on the assignment sheets and written test.

## Use of This Publication

**Written test.** This component is a criterion-referenced evaluation of every cognitive objective listed in the information sheet. If the instructor has added, deleted, or modified objectives, appropriate changes should be made on the written test. It is recommended that the test be divided into shorter tests covering three or four objectives at a time and given soon after those objectives have been covered. A selection of test items from the units covered may be used for final tests at the end of each term if desired. The test is included in the teacher edition only, but duplication is permitted for student use.

**Unit evaluation form.** This form provides teachers with a record of each student's performance on a unit of instruction. It includes space for assignment-sheet ratings, job-sheet ratings, written-test scores, and teacher comments. The unit evaluation form may also be duplicated for student use.

**Transparency masters.** Transparency masters are used to direct the students' attention to the topic of discussion. Transparency masters may provide illustrations, charts, schematics, or additional information needed to clarify and reinforce objectives included in the unit of instruction.

**Worksheet masters.** Worksheet masters provide the instructor with masters for making photocopies of the evaluation criteria used to evaluate student performance of the psychomotor skills (job sheets) included in the student edition.

## Competency Profile

**Name:** ______________________________

**Directions:** Evaluate the student using the rating scale below. Write the appropriate number/letter to indicate the degree of competency achieved. The descriptions associated with each of the numbers/letters focus on a level of student performance for each of the tasks listed. The written-test scoreline is provided for optional teacher use. It may not be applicable in all cases.

### Optional rating scales

Option A

Rating scale:

4 – **Skilled** – Can perform job with no additional training.
3 – **Moderately Skilled** – Has performed job during training program; limited additional training may be required.
2 – **Limited Skill** – Has performed job during training program; additional training is required to develop skill.
1 – **Unskilled** – Is familiar with process, but is unable to perform job.
0 – **No Exposure** – No information or practice provided during training program, complete training required.
NA – **Non-applicable**.

Option B

Yes – Can perform with no additional training.
No – Is unable to perform satisfactorily.

### Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging

________ 1. Determine specifications for selecting and installing outboard engines
________ 2. Determine specifications and parts requirements for rigging and accessories for outboard-engine boat systems
________ 3. Inspect outboard-engine boat systems and rigging
________ 4. Install and adjust outboard engines
________ 5. Install and adjust remote engine-control assemblies
________ 6. Install and adjust steering systems
________ 7. Install tank-to-engine fuel lines
________ 8. Install remote oil tanks
________ 9. Service and install batteries
________10. Install and adjust pitot systems
________11. Install and adjust transducer systems
________12. Install and adjust instruments and gauges
________13. Install and adjust electrical accessories
________14. Install and adjust hardware accessories
________15. ______________________________

________Written-test score

### Unit 2: Trailers and Safe Towing and Boat Operation

________ 1. Determine trailer specifications and parts requirements
________ 2. Select trailers for outboard-engine boat systems
________ 3. Inspect trailers
________ 4. Complete a boat-safety exam
________ 5. Perform routine maintenance on trailers

________ 6. Repair trailers
________ 7. Safely tow outboard-engine boats
________ 8. Safely launch outboard-engine boats
________ 9. Safely operate outboard-engine boats
________ 10. Safely load outboard-engine boats
________ 11. ________________________________

________ Written-test score

**Unit 3: Seasonal Procedures**

________ 1. Determine seasonal-service specifications for outboard-engine boat systems
________ 2. Winterize outboard-engine boat systems
________ 3. Summerize outboard-engine boat systems
________ 4. ________________________________

________ Written-test score

**Comments:** ________________________________

________________________________

________________________________

________________________________

________________________________

**Evaluator:** ________________ **Date:** ________________

Permission to duplicate this profile is granted.

## Instructional/Task Analysis

| Related information: What the student should know | Application: What the student should be able to do |
|---|---|

### Unit 1: Orientation to Outboard-Engine Boat Systems

| | |
|---|---|
| 1. Characteristics used to classify boat systems | 12. Determine specifications for selecting and installing outboard engines |
| 2. Definition of the term *outboard-engine boat system* | 13. Determine specifications and parts requirements for rigging and accessories for outboard-engine boat systems |
| 3. Major components of outboard-engine boat systems and their definitions | 14. Inspect outboard-engine boat systems and rigging |
| 4. Directional terms used for boat systems and their definitions | 15. Install and adjust outboard engines |
| 5. Types of hull conditions and defects and their definitons | 16. Install and adjust remote engine-control assemblies |
| 6. Common types of hardware used with rigging and accessories | 17. Install and adjust steering systems |
| | 18. Install tank-to-engine fuel lines |
| 7. Common types of instruments and gauges used on outboard-engine boat systems and their purposes | 19. Install remote oil tanks |
| | 20. Service and install batteries |
| 8. Common types of electrical accessories used on outboard-engine boat systems and their purposes | 21. Install and adjust pitot systems |
| | 22. Install and adjust transducer systems |
| 9. Common types of corrosion-protection systems and their definitions | 23. Install and adjust instruments and gauges |
| 10. Common types of hardware accessories used on outboard-engine boat systems and their purposes | 24. Install and adjust electrical accessories |
| | 25. Install and adjust hardware accessories |
| 11. Typical procedures performed when rigging outboard-engine boat systems | |

### Unit 2: Trailers and Safe Towing and Boat Operation

| | |
|---|---|
| 1. Major components of trailers used with outboard-engine boat systems and their functions | |
| 2. Design characteristics used to classify trailers | |

## Instructional/Task Analysis

| Related information: What the student should know | Application: What the student should be able to do |
|---|---|
| **Unit 2: Trailers and Safe Towing and Boat Operation** (cont.) | |
| 3. Guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle<br>4. Purposes of the trailer bow-stop and tongue-weight adjustments<br>5. Types of trailer brake systems<br>6. Principles of hydraulic-brake-system operation<br>7. Principles of electric-brake-system operation<br>8. Principles of surge-brake-system operation<br>9. Typical service procedures required for trailers | 10. Determine trailer specifications and parts requirements -<br>11. Select trailers for outboard-engine boat systems<br>12. Inspect trailers<br>13. Complete a boat-safety exam<br>14. Perform routine maintenance on trailers<br>15. Repair trailers<br>16. Safely tow outboard-engine boats<br>17. Safely launch outboard-engine boats<br>18. Safely operate outboard-engine boats<br>19. Safely load outboard-engine boats |
| **Unit 3: Seasonal Procedures** | |
| 1. Seasonal procedures required for outboard-engine boat systems and their definitions<br>2. Purposes of winterizing outboard-engine boat systems<br>3. Purposes of adding stabilizers when winterizing outboard-engine boat systems<br>4. Definition of the term *fogging*<br>5. Description of the fogging process<br>6. Typical service procedures required for winterizing outboard-engine boat systems<br>7. Purposes of summerizing outboard-engine boat systems<br>8. Typical service procedures required for summerizing outboard-engine boat systems | 9. Determine seasonal-service specifications for outboard-engine boat systems<br>10. Winterize outboard-engine boat systems<br>11. Summerize outboard-engine boat systems |

## Academic and Workplace Skill Classifications and Definitions

| Skill group | Subskill | Definition |
|---|---|---|
| Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task. |
| | Writing | Communicating a thought, idea, or fact in written form in a clear, concise manner. |
| | Arithmetic/ mathematics | Performing basic computations, applying estimating and reasoning skills, and solving practical problems using a variety of mathematical techniques. |
| | Science | Applying knowledge learned through study and practice that is based on scientific principles, methods, and techniques. |
| | Listening | Receiving, interpreting, and responding to verbal messages and other cues. |
| | Speaking | Communicating a thought, idea, or fact verbally in a clear, concise manner. |
| Thinking skills | Creative thinking | Using imagination to generate new ideas. |
| | Decision making | Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative. |
| | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results. |
| | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information. |
| | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills. |
| | Reasoning | Applying a rule or principle underlying the relationship between two or more objects when solving a problem. |
| Personal-management skills | Responsibility | Exerting a high level of effort towards goal attainment, working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration. |
| | Self-esteem | Developing self-confidence and maintaining a positive view of self. |
| | Career awareness, development, and mobility | Assessing self accurately, setting personal goals, establishing and implementing a plan, and monitoring progress. |
| | Integrity/honesty | Choosing an ethical course of action when faced with making a decision that may break with personal or societal values and recognizing the impact of violating these beliefs and codes on an organization, self, and others. |
| | Organizational effectiveness | Adapting to the organization's goals, values, culture, and traditional modes of operation. |

## Academic and Workplace Skill Classifications and Definitions

| Skill group | Subskill | Definition |
|---|---|---|
| Interpersonal skills | Teamwork | Working cooperatively with others to reach a common goal. |
| | Coaching | Helping others learn new skills. |
| | Leadership | Communicating ideas to justify position; accepting responsibility for others; and encouraging, persuading, convincing, or otherwise motivating an individual or group. |
| | Negotiation | Resolving conflict between two or more individuals through discussion and compromise. |
| | Customer service | Working and communicating with customers to satisfy their expectations. |
| | Cultural diversity | Working well with men and women and with a variety of ethnic, social, or educational backgrounds |
| Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources or creating it, and evaluating its relevance and accuracy. |
| | Organization and storage | Organizing, processing, and maintaining written or computerized records and other forms of information in a systematic way. |
| | Interpretation | Selecting and analyzing information and communicating the results to others. |
| | Processing | Using computers to acquire, organize, analyze, and communicate information. |
| Systems | Interrelationships | Knowing how social, organizational, and technological systems work and operate effectively. |
| | Monitoring | Distinguishing trends, predicting impact of actions on system operations, diagnosing deviations in systems' performance, and correcting malfunctions. |
| | Modification and design | Making suggestions to modify existing systems to improve products or services, and developing new or alternative systems. |
| Technology | Selection | Choosing procedures, tools, or equipment including computers and related technologies. |
| | Application | Demonstrating proper procedures for setting up and operating equipment. |
| | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment, including computers and other technologies. |
| Resources | Time | Selecting relevant, goal-related activities, ranking them in order of importance, allocating time, and understanding, preparing, and following schedules. |
| | Money | Using or preparing budgets, making forecasts, keeping records, and making adjustments to meet objectives. |
| | Material and facilities | Acquiring, storing, and using materials and space efficiently. |
| | Human resources | Accessing skills and distributing work accordingly; evaluating performance and providing feedback. |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** | | | |
| Determine specifications for selecting and installing outboard engines (A.S. 1) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |
| | | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Determine specifications and parts requirements for rigging and accessories for outboard-engine boat systems (A.S. 2) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Decision making | Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative |
| | Thinking skills | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |
| | | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills |
| | Interpersonal skills | Customer service | Working and communicating with customers to satisfy their expectations |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Inspect outboard-engine boat systems and rigging (A.S. 3) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Decision making | Specifying goals and constraints, generating alternatives, considering risks, and evaluating and choosing the best alternative |
| | | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| A.S. 3 (cont.) | | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills |
| | Interpersonal skills | Customer service | Working and communicating with customers to satisfy their expectations |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Install and adjust outboard engines (J.S. 1) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust remote engine-control assemblies (J.S. 2) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 2 (cont.) | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust steering systems (J.S. 3) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 3 (cont.) | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install tank-to-engine fuel lines (J.S. 4) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install remote oil tanks (J.S. 5) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 5 (cont.) | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Service and install batteries (J.S. 6) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust pitot systems (J.S. 7) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 7 (cont.) | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust transducer systems (J.S. 8) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 8 (cont.) | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust instruments and gauges (J.S. 9) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust electrical accessories (J.S. 10) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 10 (cont.) | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Install and adjust hardware accessories (J.S. 11) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 1: Orientation to Outboard-Engine Boat Systems and Rigging** (cont.) | | | |
| J.S. 11 (cont.) | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| **Unit 2: Trailers and Safe Towing and Boat Operation** | | | |
| Determine trailer specifications and parts requirements (A.S. 1) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |
| | | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Select trailers for outboard-engine boat systems (A.S. 2) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |
| | | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Inspect trailers (A.S. 3) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |
| | Interpersonal skills | Customer service | Working and communicating with customers to satisfy their expectations |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |

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## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 2: Trailers and Safe Towing and Boat Operation** (cont.) | | | |
| Complete a boat-safety exam (A.S. 4) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Reasoning | Applying a rule or principle underlying the relationship between two or more objects when solving a problem |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Perform routine maintenance on trailers (J.S. 1) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Repair trailers (J.S. 2) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 2: Trailers and Safe Towing and Boat Operation** (cont.) | | | |
| J.S. 2 (cont.) | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Safely tow outboard-engine boats (J.S. 3) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 2: Trailers and Safe Towing and Boat Operation** (cont.) | | | |
| J.S. 3 (cont.) | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Safely launch outboard-engine boats (J.S. 4) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Safely operate outboard-engine boats (J.S. 5) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |

# Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 2: Trailers and Safe Towing and Boat Operation** (cont.) | | | |
| J.S. 5 (cont.) | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Safely load outboard-engine boats (J.S. 6) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |

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# Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 3: Seasonal Procedures** | | | |
| Determine seasonal-service specifications for outboard-engine boat systems (A.S. 1) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Seeing things in the mind's eye | Mentally organizing and processing symbols, pictures, graphs, and other information |
| | | Knowing how to learn | Using efficient learning techniques to acquire and apply new knowledge and skills |
| | Information | Interpretation | Selecting and analyzing information and communicating the results to others |
| Winterize outboard-engine boat systems (J.S. 1) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |
| | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |
| Summerize outboard-engine boat systems (J.S. 2) | Basic skills | Reading | Comprehending written information and analyzing, summarizing, and applying what has been read to a specific task |

## Related Academic and Workplace Skills List

| Task | Skill group | Subskill | Definition |
|---|---|---|---|
| **Unit 3: Seasonal Procedures** (cont.) | | | |
| J.S. 2 (cont.) | | Writing | Communicating a fact in written form in a clear, concise manner |
| | Thinking skills | Problem solving | Recognizing and defining problems, devising and implementing a plan of action, and tracking and evaluating results |
| | Personal-management skills | Responsibility | Working hard to become excellent at doing tasks by setting high standards, paying attention to details, and displaying a high level of concentration |
| | Resources | Material and facilities | Acquiring, storing, and using materials and space efficiently |
| | Information | Acquisition and evaluation | Identifying need for data, obtaining it from existing sources, and evaluating its relevance and accuracy |
| | | Interpretation | Selecting and analyzing information and communicating the results to others |
| | Systems | Interrelationships | Knowing how technological systems work and operate effectively |
| | Technology | Selection | Choosing procedures, tools, or equipment |
| | | Application | Demonstrating proper procedures for setting up and operating equipment |
| | | Maintenance and troubleshooting | Preventing, identifying, or solving problems with equipment |

# Orientation to Outboard-Engine Boat Systems and Rigging
# Unit 1

## Suggested Activities

### Instructional plan

Preparation

- Review the unit in the student edition and plan your presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review the unit introduction and teaching suggestions included in the delivery and application section below, and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Display equipment and illustrations that provide examples of boat systems and types of rigging components.
- Make transparencies from the transparency masters included in the teacher pages of this unit.
- Select teacher components (written test, unit evaluation form) you want to distribute to your students. Copy and prepare these components for distribution.
- Review the job sheets and worksheets in the student edition and locate the worksheet masters included in the teacher pages of this unit. Copy and prepare extra worksheets for distribution to your students.

Delivery and application

Unit introduction

The skill areas appearing in bold-face type in the unit introduction and teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want.* These have been adapted by MAVCC.

- Provide the students with copies of the student materials. You may choose to begin by discussing the objective sheet. Review the unit and specific objectives with the students. Discuss how meeting the unit objective will improve their employability or will increase their value as an employee. Explain how the specific objectives support the unit objective. **(Listening; adapting to the organization's traditional modes of operation; emphasizing personal and career development)**
- Introduce the unit by discussing the fact that the course has concentrated on outboard engines to this point. Emphasize that the purpose of an engine is to provide power to a system—in this case, a boat system. If the students have studied other types of power products, relate the outboard-engine boat system to other types of

equipment that have engines, equipment drives, and drive trains. Point out how boats are equipped with steering systems, remote starting systems, instruments and gauges, and other components that might be found on garden tractors and all-terrain vehicles. Also have the students think about systems that might be different due to the boat's operating in water. Assist the students in identifying requirements such as bilge pumps and pitot tubes. **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

Teaching suggestions

**Objective 1** List the characteristics used to classify boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use a model boat or other prop to demonstrate the concepts discussed. For hull type, explain the concept of displacement and how buoyancy works. Point out that the load capacity of a boat is limited to how much weight can be placed in the boat until the hull is no longer able to displace enough weight in water to offset the weight of the load before water begins running over the edge of the hull. Explain planing using an example such as skipping a stone over water to show how speed can offset the mass of the boat. Show examples of boats and hulls and ask the students to determine whether the boat is a planing or displacement hull. **(Listening; reasoning; science; seeing things in the mind's eye; interpreting and processing information)**

- Provide the students with examples of hull materials. Ask the students to discuss why these materials would be used (strength versus weight, resistance to water, smooth finishes, ability to be shaped, cost, repairability, etc.). Discuss specific types of boats that might use each of these types of materials. Emphasize boats used in your area. Discuss other materials that are not used as commonly, such as rubber, cement, and canvas. **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

- Display a variety of hull shapes to introduce students to the variety of hulls used with outboard engines. Relate hull shapes to planing and displacement and then to uses. Point out specific shapes for chines, pads, strakes, pontoons, etc. **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

- For hull size, point out that boat hulls are three-dimensional objects with length, width, and height. Have the students explain how these dimensions relate to types and shapes of hulls and boat uses. Point out that there are two aspects of height: (1) the vertical amount of boat above the water line and (2) that part of the boat below the water line. Discuss how the relationship of these dimensions might affect boat performance. For example, how is the stability of a boat affected by the relationship between width and displacement? **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

## Suggested Activities

- For power source, emphasize that while this course is about outboard engines there are other sources of power used for boat systems. Provide examples of each type in equipment, video, photographs, etc. Continue with the next topic (engine configuration) to discuss types of engines used. Discuss commonalities between the types of engine, such as fuels, designs, manufacturers, etc. If your facility services engines with configurations other than outboard, discuss your training plans for those engines. Continue with the next topic (engine characteristics) by reviewing how engines are classified as presented in *Outboard-Engine Systems and Service*. **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

- Discuss ways in which boats are used (application), emphasizing outboard-engine boats and particularly those common in your area. Use the artwork in Figure 1 in the information sheet and Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," to discuss the various applications for different types of boats. Discuss how the characteristics of specific boats help make them suitable for their intended uses. For example, discuss high-speed boats and why they have planing hulls, are generally fiberglass, have tunnel bottoms, etc. Have the students discuss other applications and the characteristics of those. **(Listening; reading; reasoning; seeing things in the mind's eye; system interrelationships)**

**Objective 2** Define the term *outboard-engine boat system.*

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use the artwork in Figure 1 and Figure 2 in the information sheet and Transparency 1, "Major Components of Outboard-Engine Boat Systems," and other illustrations, models, or actual boats to illustrate your discussion. Relate those components to boat-system characteristics and applications. Use this introduction to transition to the next objective. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information)**

**Objective 3** Match the major components of outboard-engine boat systems to their correct definitions.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use the artwork in Figure 2 in the information sheet and Transparency 1, "Major Components of Outboard-Engine Boat Systems," and other illustrations and actual equipment to illustrate your discussion. Show a variety of each type of component, such as a variety of engines, different types of hulls and hull construction, various deck designs, and controls. Also discuss rigging in terms of products installed and the process of installing those products. **(Listening; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

## Suggested Activities

**Objective 4** Define directional terms used for boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- Use the artwork in Figure 5 in the information sheet and Transparency 2, "Directional Terms," and other illustrations as well as actual boats to illustrate your discussion. Point out that *fore* is similar to *forward* and *aft* is similar to *after* to help students remember the terms. One means of remembering the distinction between port and starboard is that port is left and like left has four letters. Provide the students with installation instructions, boat operating information, and other materials that use these directional terms. Remind the students that the terms are relative to a person facing forward at the midpoint of a boat. **(Listening; seeing things in the mind's eye; interpreting and processing information)**

**Objective 5** Define types of hull conditions and defects.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- Use the illustrations in Figures 6 and 7 in the information sheet, other illustrations, and actual examples of the various types of hull conditions to illustrate your discussion. Point out some hulls are designed with a hook or rocker shape to achieve specific performance results. Discuss other terms used for the various conditions, emphasizing those commonly used in your region. Discuss the causes of each type of defect and ways of preventing each. Provide examples of the different types of fouling, again emphasizing those that are a problem in your area. Show the students examples of both dry rot and wet rot. Demonstrate inspecting a craft for the various types of defects and signs that such defects may exist, such as boat performance. **(Listening; seeing things in the mind's eye; interpreting and processing information)**

**Objective 6** Label common types of hardware used with rigging and accessories.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- Use the illustrations in Figure 8 in the information sheet and provide examples of the various types of rigging hardware to illustrate your discussion. Include other types of hardware that are common in your area. Discuss the use of each type and installation guidelines and precautions. Provide the students with service manuals, installation instructions, and other documents that refer to the hardware being discussed. Emphasize the need to select appropriate hardware for the required installation. For example, the material should be rust and corrosion resistant, capable of supporting required loads, properly sized for the accessories used, etc. **(Listening; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

## Suggested Activities

**Objective 7** State the purposes of common types of instruments and gauges used on outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use the illustrations in Figure 9 in the information sheet and actual examples of the various types of instruments to illustrate your discussion. Describe their purpose, operation, and installation. Provide actual boats with such instruments. Discuss instrumentation as appropriate to boats of specific application. Discuss additional requirements for instruments, such as electrical wiring and circuit protection, pitot systems, connection to engine systems. Explain special operating principles, such as sonar, transducers, etc. **(Listening; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 8** State the purposes of the common types of electrical accessories used on outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use illustrations as well as actual equipment to provide examples of the various types of electrical accessories with which boats may be equipped. Use a variety of designs for each type of equipment, emphasizing those commonly used in your area. Discuss the operation of each type of equipment. Review installation, operation, and service procedures for each type of equipment. Stress the need for proper wiring and circuit protection. Discuss electrical equipment that is required by regulation for specific types of boats and applications. Show students boats and related wiring diagrams for various types of equipment. Describe the use of separate battery systems for electric starters and accessories. **(Listening; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 9** Define common types of corrosion-protection systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Show the students examples of corroded parts and deteriorated anodes. Use illustrations as well as actual equipment to provide examples. Review the operation of acid batteries and the roles of the anode and cathode. Many science books describe simple demonstrations of the flow of electricity when dissimilar metals are exposed to an acidic solution, such as placing a penny and a nickel in a lemon. This demonstration may be helpful in explaining how electrical flow is developed about a boat in salty or acidic water. Explain the operation of each type of protective system, emphasizing those commonly found in your area. Point out various designs of sacrificial anodes. **(Listening; science; seeing things in the mind's eye; system interrelationships)**

## Suggested Activities

**Objective 10** State the purposes of common types of hardware accessories used on outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use the illustrations in the information sheet and actual examples of each type of hardware accessory and discuss its installation, operation, and service or care procedures. Describe other types of hardware accessories that are commonly used in your area. **(Listening; seeing things in the mind's eye; system interrelationships)**

**Objective 11** List the typical procedures performed when rigging outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Have students read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems." **(Reading for content)**

- Describe and demonstrate typical procedures performed when rigging outboard-engine boat systems. Provide the students with service manuals and installation instructions that describe such procedures. Discuss the tools required and the safety precautions associated with these procedures. Emphasize those procedures that are commonly performed in your region. Invite personnel from boat-service facilities to talk to your class about procedures that they perform. **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

**Assignment Sheet 1** Determine specifications for selecting and installing outboard engines.

- Have students locate Assignment Sheet 1. Read the introduction and directions to the assignment. **(Reading/listening for direction)**

- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**

- Answer any student questions and have students complete Assignment Sheet 1.

**Assignment Sheet 2** Determine specifications and parts requirements for rigging and accessories for outboard-engine boat systems.

- Have students locate Assignment Sheet 2. Read the introduction and directions to the assignment. **(Reading/listening for direction)**

## Suggested Activities

- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**

- Answer any student questions and have students complete Assignment Sheet 2.

**Assignment Sheet 3** Inspect outboard-engine boat systems and rigging.

- Have students locate Assignment Sheet 3. Read the introduction and directions to the assignment. **(Reading/listening for direction)**

- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**

- Answer any student questions and have students complete Assignment Sheet 3.

**Job Sheet 1** Install and adjust outboard engines.

- Have students locate Job Sheet 1 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting outboard engines. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and outboard engine and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 1.

**Job Sheet 2** Install and adjust remote engine-control assemblies.

- Have students locate Job Sheet 2 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting remote engine-control assemblies. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and a remote engine-control assembly to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 2.

## Suggested Activities

**Job Sheet 3** Install and adjust steering systems.

- Have students locate Job Sheet 3 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting steering systems. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and a steering system to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 3.

**Job Sheet 4** Install tank-to-engine fuel lines.

- Have students locate Job Sheet 4 and the worksheet associated with the job sheet. Demonstrate the procedures for installing tank-to-engine fuel lines. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and tank-to-engine fuel lines to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 4.

**Job Sheet 5** Install remote oil tanks.

- Have students locate Job Sheet 5 and the worksheet associated with the job sheet. Demonstrate the procedures for installing remote oil tanks. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and a remote oil tank to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 5.

**Job Sheet 6** Service and install batteries.

- Have students locate Job Sheet 6 and the worksheet associated with the job sheet. Demonstrate the procedures for servicing and installing batteries. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and a battery to be serviced and installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 6.

## Suggested Activities

**Job Sheet 7** Install and adjust pitot systems.

- Have students locate Job Sheet 7 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting pitot systems. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and a pitot system to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 7.

**Job Sheet 8** Install and adjust transducer systems.

- Have students locate Job Sheet 8 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting transducer systems. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and a transducer system to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 8.

**Job Sheet 9** Install and adjust instruments and gauges.

- Have students locate Job Sheet 9 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting instruments and gauges. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and various instruments and gauges to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 9.

**Job Sheet 10** Install and adjust electrical accessories.

- Have students locate Job Sheet 10 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting electrical systems. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat and various electrical systems to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 10.

## Suggested Activities

**Job Sheet 11** Install and adjust hardware accessories.

- Have students locate Job Sheet 11 and the worksheet associated with the job sheet. Demonstrate the procedures for installing and adjusting hardware accessories. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.
- Provide students with a boat and various hardware accessories to be installed and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 11.

Evaluation

- Evaluate the assignment sheets. See the evaluation criteria listed at the top of each assignment sheet as well as the teacher page "Answers to Assignment Sheets."
- Evaluate the job sheets.

When the student is ready to perform a specific task, obtain a copy of the worksheet associated with each job sheet. Worksheets may be found in the student edition and in the teacher pages following the transparency masters. Then, observe the student performing the procedure.

After the student has completed the procedure, rate the student using the criteria provided on the worksheet. If the student's performance is unacceptable, have the student review the materials and perform the procedure again for evaluation.

Two sample performance evaluation keys are provided below. Many other keys are available. Select one evaluation key (grading scale) that best fits your program needs.

### Performance Evaluation Keys

**Sample A**

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

**Sample B**

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

## Suggested Activities

- Give the written test. See the teacher page "Written Test."
- Evaluate the written test. See the teacher page "Answers to Written Test."
- Compile written-test, assignment-sheet, and job-sheet scores. See the teacher page "Unit Evaluation Form."
- Reteach and retest as required.

**Suggested resources**

Resources used in developing this unit

Print media

- Buchanan, George. *The Boat Repair Manual.* New York: Arco Publishing, Inc., 1985.
- *Everything You Need to Know About Propellers,* 4th ed. Brunswick Corporation, 1992.
- Gladstone, Bernard, and Tom Bottomley. *Boatkeeper: The Boatowner's Guide to Maintenance, Repair, and Improvement.* New York: Hearst Marine Books, 1984.
- Kendall, Dave. *The Complete Book of Boat Maintenance and Repair.* Garden City, New York: Doubleday and Company, Inc., 1975.
- *Outboard Repair.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.
- United States Coast Guard. *Skipper's Safe Boating Course,* 2nd ed. St. Louis, Missouri: Mosby-Year Book, Inc., 1996.

Suggested supplemental resources

Print media

- Printed materials available from the U.S. Coast Guard and U.S. Coast Guard Auxiliary.
- Printed materials available from each state boating-law administering agency.
- *Boating Magazine.* 1633 Broadway, New York, New York 10019, (212) 767-5585.
- *Motor Boating and Sailing.* 250 W. 55th St., New York, New York 10019, (212) 649-4099.
- *Trailer Boats.* Poole Publications, Inc., 20700 Belshaw Ave., Carson, California, (310) 537-6322.
- Service manuals and operator's manuals for systems and equipment covered in this unit. Available from equipment manufacturers.

## Suggested Activities

- Catalogs, brochures, and promotional materials covering accessories and rigging. Available from equipment manufacturers.

Nonprint media

- *Cosmetic Gelcoat and Fiberglass Repair.* This is a three-volume set of VHS tapes that cover how to repair fiberglass hulls and how to prevent damage when installing hardware. The tapes are 100, 104, and 50 minutes respectively. Available from Sea Tow International, 1560 Youngs Ave., Southold, New York 11971, (516) 765-3660, website http://www.boatingsafety.com.

- *Top 60 Tips—Maintenance.* This 45-minute video discusses many aspects of boat maintenance, including hull and hardware care, as well as seasonal procedures suitable to Unit 3. Available from Sea Tow International.

- U.S. Coast Guard Navigation Center (NAVCEN) website http://www.navcen.uscg.mil/

Organizations

- Association of Marine Technicians (AMTECH). An organization dedicated to improving marine service through cooperation, certification, and education. 455 Knollwood Terrace, Roswell, Georgia 30075, (800) 467-0982.

- Boat Owners Association of The United States (BoatUS). Provides publications, resources, information, equipment, and other useful materials with discounts to members. Maintains a helpful website. 880 S. Pickett St., Alexandria, Virginia 22304, website http://boatus.com.

- National Marine Manufacturers Association. A good source of information about trends in watercraft sales and production. 200 E. Randolph Drive, Suite 5100, Chicago, Illinois 60601, (312) 946-6200, website http://www.nmma.com.

- Nautical Know How, Inc. Sponsors of a useful website that provides state boating quizzes, on-line safety and skills courses, and other resources. 5102 S.E. Nassau Terrace, Stuart, Florida 34997, (888) 297-2076, website http://boatsafe.com.

- United States Coast Guard. Of particular interest is the Office of Boating Safety. Contact the national headquarters or visit their website to obtain information about your nearest facility. (800) 368-5647, website http://www.uscg.mil.

- United States Coast Guard Auxillary. Contact the USCG or visit the Auxiliary website to determine how to contact your local chapter, website http://www.cgaux.org.

- United States Power Squadron. Provides information, quizzes, and materials to promote boat safety. P.O. Box 30423, Raleigh, North Carolina 27622, (888) FOR-USPS, website http://www.usps.org.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Answers to Assignment Sheets

**Assignment Sheet 1**—Student performance should be evaluated according to the criteria listed on the assignment sheet. The answers will depend upon the equipment selected by the instructor.

**Assignment Sheet 2**—Student performance should be evaluated according to the criteria listed on the assignment sheet. Student answers to the scenarios will vary.

**Assignment Sheet 3**—Student performance should be evaluated according to the criteria listed on the assignment sheet. Student answers will vary.

## Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Answers to Written Test

1. Answers may appear in any order.

   - Hull type
   - Hull material
   - Hull shape
   - Hull size
   - Power source
   - Engine configuration
   - Engine characteristics
   - Application

2. System consisting of a boat hull and engine where the engine is normally mounted on the outside of the boat hull

3. a. 5
   b. 3
   c. 2
   d. 4
   e. 1
   f. 6
   g. 8
   h. 10
   i. 11
   j. 7
   k. 9

4. a. Front
   b. Back
   c. Right
   d. Left

5. a. Condition of the hull in which the center portion of the hull has been bent or has warped above its original contour

   b. Condition of the hull in which the center portion of the hull has been bent or warped below its original contour

   c. Fine cracks that form in fiberglass hulls and other fiberglass components

   d. Deposits on the outside of a boat hull

   e. Decomposition of the hull due to the action of bacteria or fungus

6. a. Cable guide
   b. Clamp
   c. Pulley
   d. Tie-down
   e. Cleat
   f. Shim

## Answers to Written Test

7. a. Indicates the amount of fuel in the fuel tank
   b. Indicates whether the charging system is providing output
   c. Indicates the temperature of the engine coolant or an overheat condition
   d. Indicates the output pressure of the cooling-system pump
   e. Indicates the speed of the boat over water
   f. Indicates engine speed
   g. Indicates the angle or position of the trim
   h. Indicates oil pressure or oil-tank level or low oil levels
   i. Indicates underwater features

8. a. Warns other boaters of the presence of the boat

   b. Removes water that has splashed or leaked into the boat

   c. Indicate the location and orientation of the boat to other boaters

   d. Provides low-speed operation of the boat

   e. Provides audio and video entertainment to boat passengers

   f. Provides voice or electronic data exchange between boats or between the boat and land-based facilities

   g. Allows the boat operator to determine the position of the boat and the position of other features relative to the boat

9. a. Disposable component that is usually mounted to the engine and is designed to deteriorate more easily than more-important components

   b. Plate mounted to the transom and electrically interconnected to allow electrical flow that deteriorates the plate

   c. Electrical device that is wired into the boat's electrical grounding system to block galvanic flow when a boat is connected to a land-based power source

   d. Solid-state controller system that applies battery power to a set of external electrodes to ensure electrical flow to immersed metal requiring protection

10. a. Holds the engine away from the transom during transport and storage

    b. Raise and lower the engine vertically to change the transom height in order to improve acceleration, speed, and fuel economy

    c. Supplement power trimming of the engine

    d. Protect the boat from water, sun, and other environmental conditions

    e. Protect the passenger area of the boat

## Answers to Written Test

11. Answer should include any nine of the following.

    - Install and adjust outboard engine
    - Install and adjust remote engine-control assembly
    - Install and adjust remote steering system
    - Install tank-to-engine fuel line
    - Install remote oil tank
    - Install and service battery
    - Install and adjust pitot system
    - Install and adjust transducer system
    - Install and adjust instruments and gauges
    - Install and adjust electrical accessories
    - Inspect boat systems and rigging

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Written Test

Name ______________________________ Score ______________

1. List the characteristics used to classify boat systems. Write your answers on the blanks provided below.

   a. ______________________________
   b. ______________________________
   c. ______________________________
   d. ______________________________
   e. ______________________________
   f. ______________________________
   g. ______________________________
   h. ______________________________

2. Define the term *outboard-engine boat system*. Write the definition on the blanks provided beside the term below.

   Outboard-engine boat system ______________________________
   ______________________________
   ______________________________

3. Match the major components of outboard-engine boat systems to their correct definitions. Write the numbers on the blanks provided below and on the next page.

   ______ a. Rear of the hull that provides a structure for mounting the engine
   ______ b. Components that support the operation of the boat system without being essential to the function or control of the engine and steering system
   ______ c. Overall structure of the boat that defines its general shape
   ______ d. Components that allow the operator to raise and lower the engine
   ______ e. Power source that moves the boat through the water

   1. Engine
   2. Hull
   3. Accesories
   4. Hydraulic controls
   5. Transom

## Written Test

________ f. Components that allow the operator to adjust functions such as engine speed, choke-valve setting, and gear ratio

________ g. Components that allow the operator to change the direction of boat travel

________ h. Front portion of the hull that cuts through the water as the boat travels forward

________ i. Configuration of the attachments made to a boat

________ j. Horizontal surfaces that form the enclosures in the hull

________ k. Places for the passengers and operator to sit

6. Engine controls
7. Deck
8. Steering controls
9. Seats
10. Bow
11. Rigging

4. Define directional terms used for boat systems. Write your answers on the blanks provided beside the terms below.

   a. Fore ______________________________

   b. Aft ______________________________

   c. Starboard ______________________________

   d. Port ______________________________

5. Define types of hull conditions and defects. Write your answers on the blanks provided beside the terms below.

   a. Hook ______________________________
   ______________________________

   b. Rocker ______________________________
   ______________________________

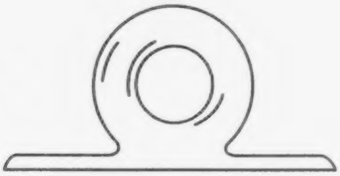
   c. Crazing ______________________________
   ______________________________

   d. Fouling ______________________________
   ______________________________

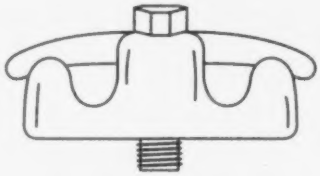
   e. Rot ______________________________
   ______________________________

## Written Test

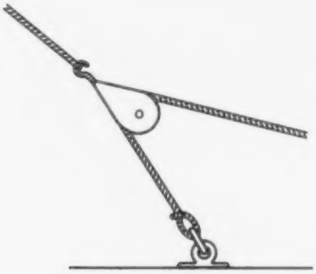
6. Label common types of hardware used with rigging and accessories. Write your answers on the blanks provided under the illustrations below.



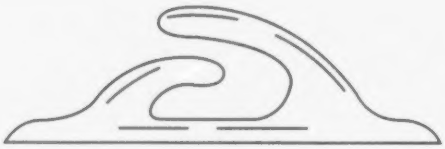
a. ______________________



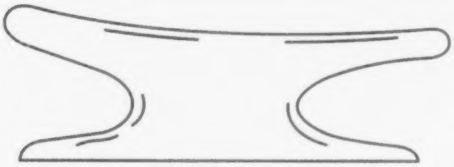
b. ______________________



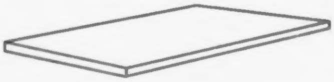
c. ______________________



d. ______________________



e. ______________________



f. ______________________

7. State the purposes of common types of instruments and gauges used on outboard-engine boat systems. Write your answers on the blanks provided beside the terms below and on the following page.

   a. Fuel gauge ______________________

   b. Ammeter ______________________

   c. Engine-temperature gauge ______________________

d. Water-pressure gauge ____________________

____________________

e. Speedometer ____________________

____________________

f. Tachometer ____________________

____________________

g. Trim gauge ____________________

____________________

h. Oil gauge ____________________

____________________

i. Depth indicator ____________________

____________________

8. State the purposes of common types of electrical accessories used on outboard-engine boat systems. Write your answers on the blanks provided beside the terms below.

a. Horn ____________________

____________________

b. Bilge pump ____________________

____________________

c. Running lights ____________________

____________________

d. Trolling motor ____________________

____________________

e. Entertainment equipment ____________________

____________________

f. Communications equipment ____________________

____________________

g. Navigational equipment ____________________

____________________

## Written Test

9. Define common types of corrosion-protection systems. Write your answers on the blanks provided beside the terms below.

   a. Sacrificial anode ______________________________

   ______________________________

   b. Anodic kit ______________________________

   ______________________________

   c. Galvanic isolator ______________________________

   ______________________________

   d. Cathode system ______________________________

   ______________________________

10. State the purposes of common types of hardware accessories used on outboard-engine boat systems. Write your answers on the blanks provided beside the terms below.

    a. Transom savers ______________________________

    ______________________________

    ______________________________

    b. Jack plates ______________________________

    ______________________________

    ______________________________

    c. Trim planes ______________________________

    ______________________________

    ______________________________

    d. Boat covers ______________________________

    ______________________________

    ______________________________

    e. Boat tops ______________________________

    ______________________________

    ______________________________

## Written Test

11. List nine of the typical procedures performed when rigging outboard-engine boat systems. Write your answers on the blanks provided below.

a. ______________________________

b. ______________________________

c. ______________________________

d. ______________________________

e. ______________________________

f. ______________________________

g. ______________________________

h. ______________________________

i. ______________________________

Permission to duplicate this test is granted.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Unit Evaluation Form

Student name ______________________ Unit rating __________

**Assignment-sheet ratings**

**Assignment Sheet 1**—Determine Specifications for Selecting and Installing Outboard Engines Rating ______

Comments: ______________________

______________________

**Assignment Sheet 2**—Determine Specifications and Parts Requirements for Rigging and Accessories for Outboard-Engine Boat Systems Rating ______

Comments: ______________________

______________________

**Assignment Sheet 3**—Inspect Outboard-Engine Boat Systems and Rigging Rating ______

Comments: ______________________

______________________

**Job-sheet ratings**

**Job Sheet 1**—Install and Adjust Outboard Engines Rating ______

Comments: ______________________

______________________

**Job Sheet 2**—Install and Adjust Remote Engine-Control Assemblies Rating ______

Comments: ______________________

______________________

**Job Sheet 3**—Install and Adjust Steering Systems Rating ______

Comments: ______________________

______________________

## Unit Evaluation Form

**Job Sheet 4**—Install Tank-to-Engine Fuel Lines Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 5**—Install Remote Oil Tanks Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 6**—Service and Install Batteries Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 7**—Install and Adjust Pitot Systems Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 8**—Install and Adjust Transducer Systems Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 9**—Install and Adjust Instruments and Gauges Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 10**—Install and Adjust Electrical Accessories Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 11**—Install and Adjust Hardware Accessories Rating ________

Comments: ______________________________________________

______________________________________________

## Unit Evaluation Form

**Written-test scores**

Pretest ____________ Posttest ____________ Other ____________

Comments: ________________________________________________

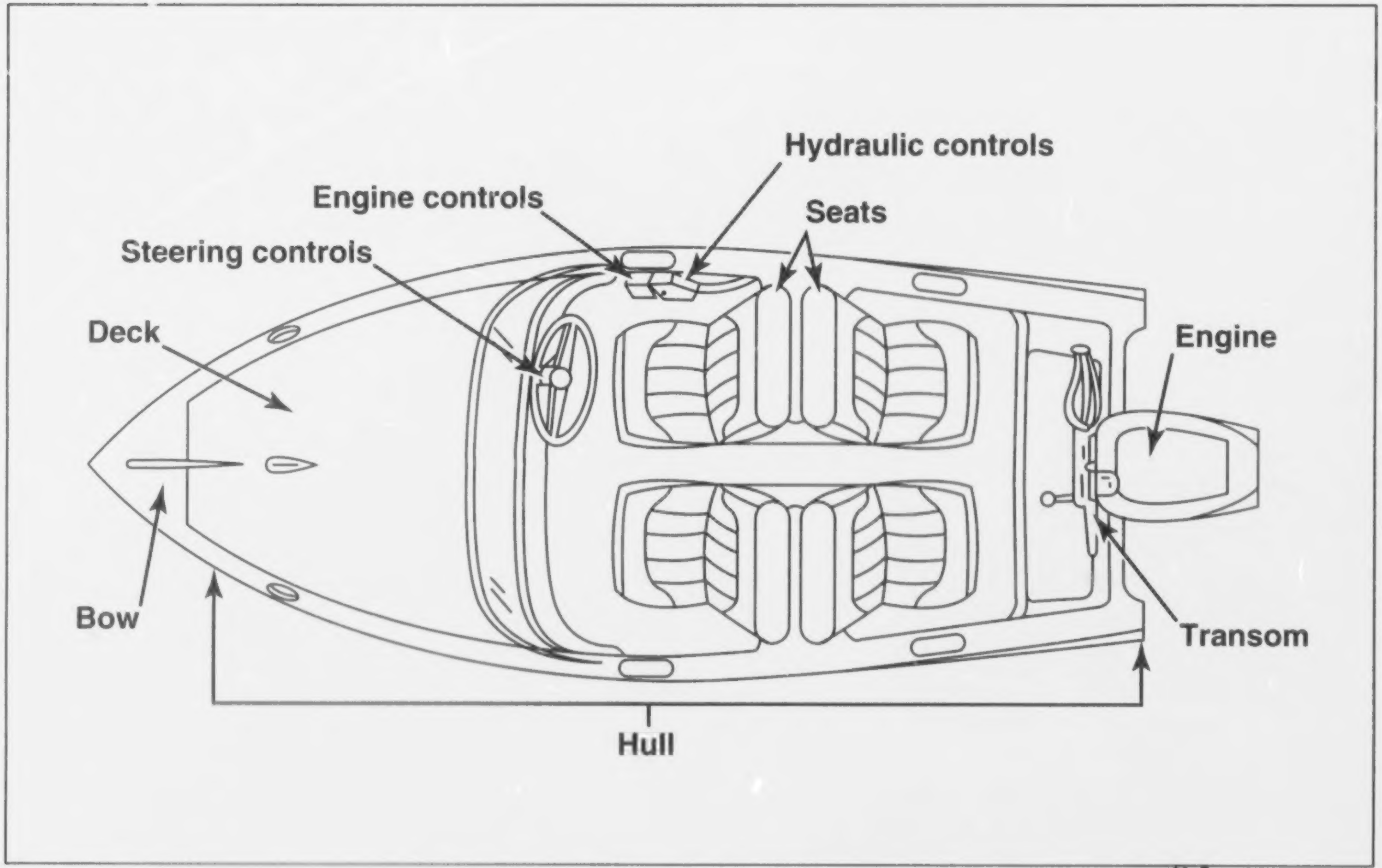
________________________________________________

**Teacher signature** ______________________________ Date ______________

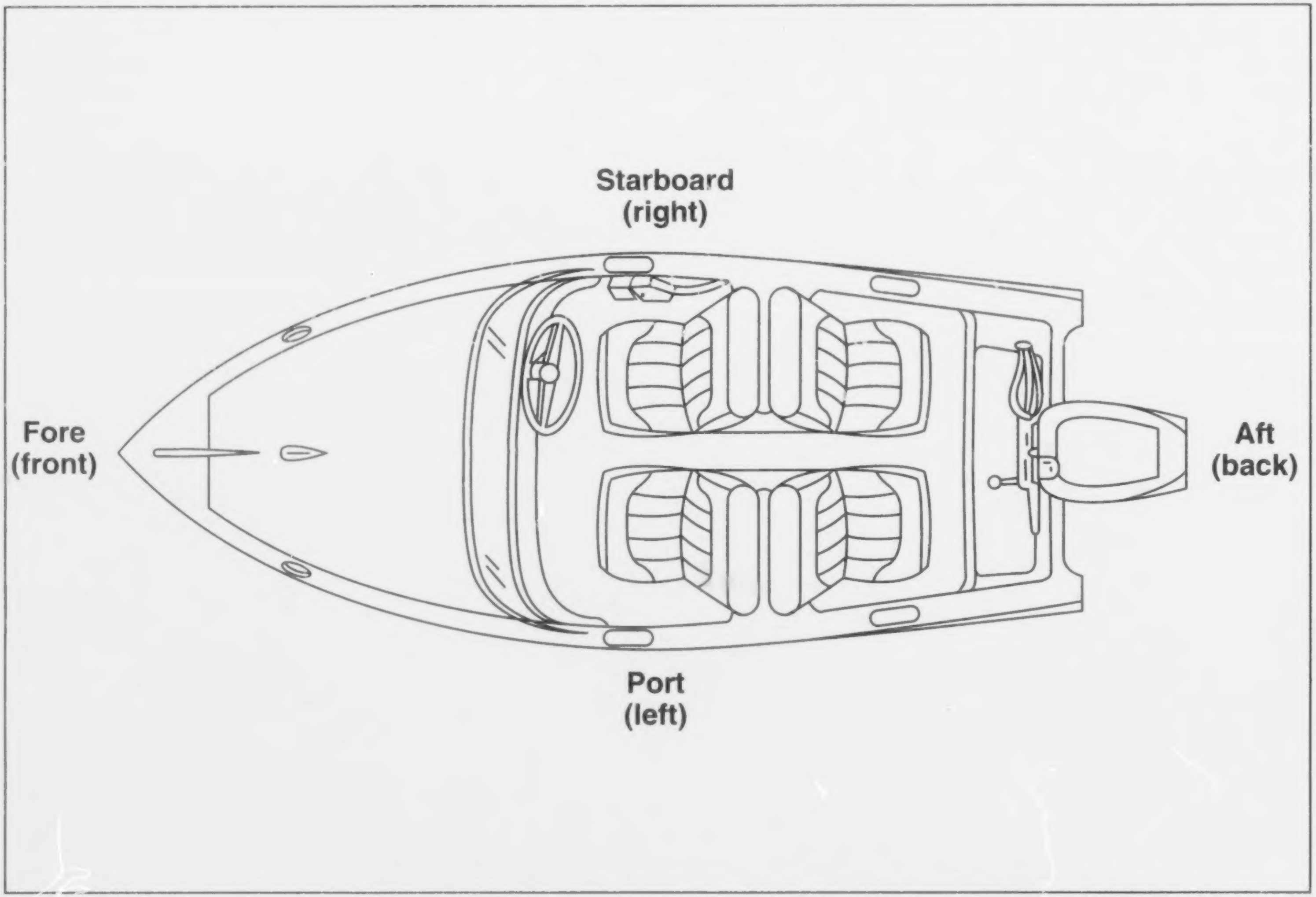
**Student signature** ______________________________ Date ______________

Permission to duplicate this form is granted.

# Major Components of Outboard-Engine Boat Systems


Hydraulic controls
Engine controls
Seats
Steering controls
Deck
Engine
Bow
Transom
Hull

# Directional Terms


Starboard
(right)
Fore
(front)
Aft
(back)
Port
(left)

# Job Sheet 1

## Worksheet—Install and Adjust Outboard Engines

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

Job Sheet 1

## Worksheet—Install and Adjust Outboard Engines

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

## Job Sheet 2

## Worksheet—Install and Adjust Remote Engine-Control Assemblies

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 2

## Worksheet—Install and Adjust Remote Engine-Control Assemblies

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

## Job Sheet 3

## Worksheet—Install and Adjust Steering Systems

Name ____________________ Attempt number ________

Date ____________________

---

**Part A: Pre-performance check**

Job ____________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ____________________

  Equipment model/type and code ____________________

  ____________________

- Complete the following service-manual information.

  Service-manual title ____________________

  Section/page number of procedure ____________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ____________________

# Job Sheet 3

## Worksheet—Install and Adjust Steering Systems

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________________

________________________________________________________________

## Job Sheet 4

## Worksheet—Install Tank-to-Engine Fuel Lines

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

# Job Sheet 4

## Worksheet—Install Tank-to-Engine Fuel Lines

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________

________________________________________

---

## Job Sheet 5

## Worksheet—Install Remote Oil Tanks

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ____________________________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

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**Instructor's signature** ______________________________

## Job Sheet 5

## Worksheet—Install Remote Oil Tanks

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________________

____________________________________________________________________

____________________________________________________________________

## Job Sheet 6

## Worksheet—Service and Install Batteries

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 6

## Worksheet—Service and Install Batteries

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

## Job Sheet 7

## Worksheet—Install and Adjust Pitot Systems

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 7

## Worksheet—Install and Adjust Pitot Systems

---

**Part B:** **Performance evaluation**

**Evaluation criteria** **Rating**

Correct procedures identified for assigned equipment. ______

Procedures completed correctly. ______

Proper tools used correctly. ______

Safety precautions observed. ______

Service meets specifications. ______

Clean-up and follow-up actions adequate. ______

**Overall rating** ______

**Evaluator's comments** ______________________________

______________________________________________

______________________________________________

---

## Job Sheet 8

## Worksheet—Install and Adjust Transducer Systems

Name ______________________________ Attempt number __________

Date ______________________________

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

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**Instructor's signature** ______________________________

# Job Sheet 8

## Worksheet—Install and Adjust Transducer Systems

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

____________________________________________

____________________________________________

## Job Sheet 9

### Worksheet—Install and Adjust Instruments and Gauges

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A:** **Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 9

## Worksheet—Install and Adjust Instruments and Gauges

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

## Job Sheet 10

## Worksheet—Install and Adjust Electrical Accessories

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 10

## Worksheet—Install and Adjust Electrical Accessories

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | _______ |
| Procedures completed correctly. | _______ |
| Proper tools used correctly. | _______ |
| Safety precautions observed. | _______ |
| Service meets specifications. | _______ |
| Clean-up and follow-up actions adequate. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** ________________________________________

__________________________________________________________

__________________________________________________________

## Job Sheet 11

## Worksheet—Install and Adjust Hardware Accessories

Name ____________________ Attempt number ________

Date ____________________

---

**Part A:** **Pre-performance check**

Job ____________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ____________________

  Equipment model/type and code ____________________

  ____________________

- Complete the following service-manual information.

  Service-manual title ____________________

  Section/page number of procedure ____________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ____________________

# Job Sheet 11

## Worksheet—Install and Adjust Hardware Accessories

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Suggested Activities

### Instructional plan

#### Preparation

- Review the unit in the student edition and plan your presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review the unit introduction and teaching suggestions included in the delivery and application section below, and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Obtain information on boating safety laws and regulations from the U.S. Coast Guard, U.S. Coast Guard Auxiliary, and your state's boating-law administering agency.

- Prepare the classroom by displaying posters, equipment, and tools related to trailers, towing, and safe boat operation.

- Make a transparency from the transparency master included in the teacher pages of this unit.

- Select teacher components (written test, unit evaluation form) you want to distribute to your students. Copy and prepare these components for distribution.

- Review the job sheets and worksheets in the student edition and locate the worksheet masters included in the teacher pages of this unit. Copy and prepare extra worksheets for distribution to your students.

#### Delivery and application

Unit introduction

The skill areas appearing in bold-face type in the unit introduction and teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

- Provide the students with copies of the student materials. You may choose to begin by discussing the objective sheet. Review the unit and specific objectives with the students. Discuss how meeting the unit objective will improve their employability or will increase their value as an employee. Explain how the specific objectives support the unit objective. **(Listening; adapting to the organization's traditional modes of operation; emphasizing personal and career development)**

## Suggested Activities

- Introduce the unit by discussing the need to transport boats to and from bodies of water and doing so safely. Point out that transport systems must match the boat to be effective—that is, the trailer must hold the boat securely and support it adequately and the tow vehicle must pull the load and stop in a safe distance. Continue the introduction by pointing out that operating a boat is much like driving a car, that there are rules to be obeyed just as there are rules for the road, and that there are safe operating principles that should be observed. Service technicians must be familiar with these rules and guidelines because technicians are often required to transport and operate boats as part of the test evaluation and service requirements and to ensure that rigging installations have been made properly. **(Listening; adapting to the organization's traditional modes of operation; emphasizing personal and career development)**

Teaching suggestions

**Objective 1** Match the major components of trailers used with outboard-engine boat systems to their correct functions.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Use Figure 1 in the information sheet, Transparency 1, and actual equipment to discuss the components of a trailer. Describe the purpose and function of each component. Discuss service procedures associated with components such as brakes and wheel bearings. Relate these procedures to those with which the students may already be familiar. Demonstrate adjustments such as tongue-weight, bow-stop, and bunk positioning. Discuss various types of hitches and demonstrate the operation of each. Point out the location of the boat label and discuss the information provided by the label. Discuss requirements and regulations applicable to boat trailers specific to your area. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; systems interrelationships)**

**Objective 2** List the design characteristics used to classify trailers.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Relate the characteristics used to classify trailers to the components covered in the previous objective. For example, bunks and rollers are used to classify trailers as a means of support. The load capacity of the trailer is listed on the tongue label. The degree of protection for wheel bearings, lights, etc., determines whether a boat is submersible. Provide examples of tilt systems and demonstrate their operation. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; systems interrelationships)**

## Suggested Activities

**Objective 3** State guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Discuss the guidelines for selecting a proper trailer and tow vehicle. Discuss how to determine each of the factors discussed. For example, explain how to determine the weight of a boat system and compare that to the capacity of the trailer. Demonstrate measuring a boat and comparing it to the configuration of the trailer. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 4** Describe the purposes of the trailer bow-stop and tongue-weight adjustments.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Demonstrate proper bow-stop and tongue-weight adjustments for a variety of trailers. Emphasize the need for proper adjustments to allow the boat and trailer to track properly. Discuss problems that are likely to result from improper adjustments. If available, show photos or other illustrations of damage to boats, trailers, and tow vehicles that resulted from improper adjustments. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 5** List types of trailer brake systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Discuss reasons for the need for trailer brake systems. Point out that many of today's vehicles, such as sport-utility vehicles, have the structural strength and the horsepower needed to tow mid-size boats but lack the braking capacity required to safely stop the vehicle and loaded trailer. Summarize the operation of each type of brake system, which will be explained in detail in the next three objectives. Explain the operation of each and compare their suitability for given boat systems and trailers. Cover service requirements and procedures for each. Discuss methods for connecting tow-vehicle and trailer brake systems. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 6** Complete statements about the principles of hydraulic-brake-system operation.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Review the operation of hydraulic brake systems, relating this type of trailer-brake system to other systems with which students may be familiar. Discuss the selection of brake fluids and guidelines for using them (DOT ratings, not mixing different types of fluid, etc.) Explain symptoms of poor brake performance and probable causes. Describe and demonstrate related service procedures. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 7** Complete statements about the principles of electric-brake-system operation.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Review the operation of electric brake systems, relating this type of trailer-brake system to other systems with which students may be familiar. Describe guidelines for installing electric brake systems, such as selecting wiring, connectors, circuit protection, etc. Explain symptoms of poor brake performance and probable causes. Describe and demonstrate related service procedures. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 8** Complete statements about the principles of surge-brake-system operation.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Review the operation of surge brake systems, relating this type of trailer-brake system to those systems with which students may be familiar. Discuss limitations of surge brake systems. Explain symptoms of poor brake performance and probable causes. Describe and demonstrate related service procedures. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 9** List the typical service procedures required for trailers.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Discuss the purpose of each service procedure. Demonstrate the procedures in a variety of designs, emphasizing technical and safety guidelines. Discuss specific trailer problems associated with the fact that boat trailers are frequently in water. Describe the selection of proper lubricants and lubrication points and methods. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Assignment Sheet 1** Determine trailer specifications and parts requirements.

- Have students read Student Supplement 1, "Guidelines for Outboard-Engine Boat-System Transport and Operation."

## Suggested Activities

- Have students locate Assignment Sheet 1. Read the introduction and directions to the assignment. **(Reading/listening for direction)**
- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**
- Answer any student questions and have students complete Assignment Sheet 1.

**Assignment Sheet 2** Select trailers for outboard-engine boat systems.

- Have students locate Assignment Sheet 2. Read the introduction and directions to the assignment. **(Reading/listening for direction)**
- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**
- Answer any student questions and have students complete Assignment Sheet 2.

**Assignment Sheet 3** Inspect trailers.

- Have students locate Assignment Sheet 3. Read the introduction and directions to the assignment. **(Reading/listening for direction)**
- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**
- Answer any student questions and have students complete Assignment Sheet 3.

**Assignment Sheet 4** Complete a boat-safety exam.

- Have students locate Assignment Sheet 4. Read the introduction and directions to the assignment. **(Reading/listening for direction)**
- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**
- Answer any student questions and have students complete Assignment Sheet 4.

## Suggested Activities

**Job Sheet 1** Perform routine maintenance on trailers.

- Have students locate Job Sheet 1 and the worksheet associated with the job sheet. Demonstrate the procedures for performing routine maintenance on trailers. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a trailer and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 1.

**Job Sheet 2** Repair trailers.

- Have students locate Job Sheet 2 and the worksheet associated with the job sheet. Demonstrate the procedures for repairing trailers. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a trailer requiring repair and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 2.

**Job Sheet 3** Safely tow outboard-engine boats.

- Have students locate Job Sheet 3 and the worksheet associated with the job sheet. Demonstrate the procedures for towing outboard-engine boats. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat, trailer, and towing vehicle and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 3.

**Job Sheet 4** Safely launch outboard-engine boats.

- Have students locate Job Sheet 4 and the worksheet associated with the job sheet. Demonstrate the procedures for safely launching outboard-engine boats. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with a boat on a trailer with a towing vehicle and a place to launch the boat and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 4.

## Suggested Activities

**Job Sheet 5** Safely operate outboard-engine boats.

- Have students locate Job Sheet 5 and the worksheet associated with the job sheet. Demonstrate the procedures for safely operating outboard-engine boats. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.
- Provide students with a boat and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 5.

**Job Sheet 6** Safely load outboard-engine boats.

- Have students locate Job Sheet 6 and the worksheet associated with the job sheet. Demonstrate the procedures for safely loading outboard-engine boats. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.
- Provide students with a boat in the water, trailer, and towing vehicle and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 6.

Evaluation

- Evaluate the assignment sheets. See the evaluation criteria listed at the top of each assignment sheet as well as the teacher page "Answers to Assignment Sheets."
- Evaluate the job sheets.

  When the student is ready to perform a specific task, obtain a copy of the worksheet associated with each job sheet. Worksheets may be found in the student edition and in the teacher pages following the transparency master. Then, observe the student performing the procedure.

  After the student has completed the procedure, rate the student using the criteria provided on the worksheet. If the student's performance is unacceptable, have the student review the materials and perform the procedure again for evaluation.

  Two sample performance evaluation keys are provided on the next page. Many other keys are available. Select one evaluation key (grading scale) that best fits your program needs.

## Suggested Activities

### Performance Evaluation Keys

**Sample A**

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

**Sample B**

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

- Give the written test. See the teacher page "Written Test."
- Evaluate the written test. See the teacher page "Answers to Written Test."
- Compile written-test, assignment-sheet, and job-sheet scores. See the teacher page "Unit Evaluation Form."
- Reteach and retest as required.

## Suggested resources

Resources used in developing this unit

Print media

- Buchanan, George. *The Boat Repair Manual.* New York: Arco Publishing, Inc., 1985.
- *Everything You Need to Know About Propellers,* 4th ed. Brunswick Corporation, 1992.
- Gladstone, Bernard, and Tom Bottomley. *Boatkeeper: The Boatowner's Guide to Maintenance, Repair, and Improvement.* New York: Hearst Marine Books, 1984.
- Kendall, Dave. *The Complete Book of Boat Maintenance and Repair.* Garden City, New York: Doubleday and Company, Inc., 1975.
- *Outboard Repair.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.
- United States Coast Guard. *Skipper's Safe Boating Course,* 2nd ed. St. Louis, Missouri: Mosby-Year Book, Inc., 1996.

## Suggested Activities

Suggested supplemental resources

Print media

- Printed materials available from the U.S. Coast Guard and U.S. Coast Guard Auxiliary.
- Printed materials available from each state boating-law administering agency.
- *Boating Magazine.* 1633 Broadway, New York, New York 10019, (212) 767-5585.
- *Motor Boating and Sailing.* 250 W. 55th St., New York, New York 10019, (212) 649-4099.
- *Trailer Boats.* Poole Publications, Inc., 20700 Belshaw Ave., Carson, California, (310) 537-6322.
- Service manuals and operator's manuals for systems and equipment covered in this unit. Available from equipment manufacturers.
- Catalogs, brochures, and promotional materials covering accessories and rigging. Available from equipment manufacturers.

Nonprint media

- *Rules of the Road.* This video covers 38 USCG rules for boat operation. 45 minutes. Available from Sea Tow International, 1560 Youngs Ave., Southold, New York 11971, (516) 765-3660, website http://www.boatingsafety.com.
- *Single-Screw Boat Handling.* This extensive 75-minute video goes beyond boat operation by presenting information on inspecting boats and trailers, trailering boats, and proper launching techniques. Available from Sea Tow International.
- *Top 60 Tips—Boat Handling.* Guidelines for the proper and safe operation of boats are presented. 45 minutes. Available from Sea Tow International.
- *Top 60 Tips—Safety.* This 45-minute video focuses on the safe operation of boats. Available from Sea Tow International.
- *USPS Video Boating Course.* This 80-minute video is accompanied by a 240-page manual that covers many aspects of loading, trailering, launching, and handling boats. Available from United States Power Squadron, P.O. Box 30423, Raleigh, North Carolina 27622, (888) FOR-USPS.
- U.S. Coast Guard Navigation Center (NAVCEN) website http://www.navcen.uscg.mil/

## Suggested Activities

Organizations

- Association of Marine Technicians (AMTECH). An organization dedicated to improving marine service through cooperation, certification, and education. 455 Knollwood Terrace, Roswell, Georgia 30075, (800) 467-0982.
- Boat Owners Association of The United States (BoatUS). Provides publications, resources, information, equipment, and other useful materials with discounts to members. Maintains a helpful website. 880 S. Pickett St., Alexandria, Virginia 22304, website http://boatus.com.
- National Marine Manufacturers Association. A good source of information about trends in watercraft sales and production. 200 E. Randolph Drive, Suite 5100, Chicago, Illinois 60601, (312) 946-6200, website http://www.nmma.com.
- Nautical Know How, Inc. Sponsors of a useful website that provides state boating quizzes, on-line safety and skills courses, and other resources. 5102 S.E. Nassau Terrace, Stuart, Florida 34997, (888) 297-2076, website http://boatsafe.com.
- United States Coast Guard. Of particular interest is the Office of Boating Safety. Contact the national headquarters or visit their website to obtain information about your nearest facility. (800) 368-5647, website http://www.uscg.mil.
- United States Coast Guard Auxillary. Contact the USCG or visit the Auxiliary website to determine how to contact your local chapter. website http://www.cgaux.org.
- United States Power Squadron. Provides information, quizzes, and materials to promote boat safety. P.O. Box 30423, Raleigh, North Carolina 27622, (888) FOR-USPS, website http://www.usps.org.

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Answers to Assignment Sheets

**Assignment Sheet 1**—Student performance should be evaluated according to the criteria listed on the assignment sheet. The answers will depend upon the equipment selected by the instructor.

**Assignment Sheet 2**—Student performance should be evaluated according to the criteria listed on the assignment sheet. The answers will depend upon the equipment selected by the instructor.

**Assignment Sheet 3**—Student performance should be evaluated according to the criteria listed on the assignment sheet. The answers will depend upon the equipment selected by the instructor.

**Assignment Sheet 4**

Note: The following answers are based on information in the United States Coast Guard booklet *Federal Requirements and Safety Tips for Recreational Boats,* produced by the U.S. Coast Guard Boating Education Branch 4/94. The instructor should review these answers based on recent information he or she has obtained from the Coast Guard or from the state boating-law administering agency.

1. c
2. d
3. c
4. b
5. d
6. d
7. b
8. b
9. b
10. d
11. b
12. c
13. a
14. b
15. c

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Answers to Written Test

1.
   a. 5
   b. 3
   c. 8
   d. 10
   e. 4
   f. 1
   g. 6
   h. 7
   i. 2
   j. 9

2. Answers may appear in any order.

   - Type of boat support used—rollers or bunks
   - Degree of submersibility—submersible or fully submersible
   - Use of tilt control
   - Load capacity

3. Answers may appear in any order.

   - The trailer must be able to accommodate the weight of the boat.
   - The trailer must be able to accommodate the shape and dimensions of the boat.
   - The hitch system of the trailer must be compatible with the hitch system on the tow vehicle.

4.
   a. The bow stop provides the forward rest for the boat. The bow stop must be set at the proper height to correctly distribute the balance of the load as the boat is thrust forward on the trailer by the momentum of towing.

   b. The weight of the boat and trailer must be properly balanced at the hitch system between the tow vehicle and the trailer. Excessive weight on the bumper can damage the tow vehicle or cause separation between the tow vehicle and the trailer. Excessive weight on the trailer can cause the trailer to track erratically. The tongue can be lengthened or shortened to change the balance point of the trailer, which changes the amount of weight that rests directly on the bumper of the tow vehicle.

5. Answers may appear in any order.

   - Hydraulic
   - Electric
   - Surge

6.
   a. Hydraulic
   b. electrical
   c. electricity; brake piston; drum
   d. hydraulic-piston actuator; spring; drum

7.
   a. electrical circuit; brake lights
   b. brake-light; electromagnetic
   c. electromagnet; solenoid; drum
   d. electromagnet; spring; drum

## Answers to Written Test

8. a. brakes
   b. surge brakes
   c. surge brakes

9. Answers should include any six of the following.

- Pack wheel bearings
- Replace, repair, or rotate tires
- Adjust or replace brake pads
- Replace lamps or electrical wiring
- Lubricate mechanical parts such as the hitch or the tongue jack
- Adjust, repair, or replace bunks
- Replace rollers
- Adjust bow stop or tongue weight

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Written Test

Name ______________________________ Score ______________

1. Match the major components of trailers used with outboard-engine boat systems to their correct functions. Write the numbers on the blanks provided.

_______ a. Provides a mechanism for loading a boat onto its trailer and for lowering the boat from the trailer

_______ b. Raises and lowers the tongue to position the hitch to the tow-vehicle bumper and to level the trailer during storage

_______ c. Supports the frame and secures the tire-and-wheel assemblies to the trailer

_______ d. Allows a portion of the boat support to be raised mechanically, electrically, or hydraulically

_______ e. Forms the support framework for the other trailer components

_______ f. Fastens the trailer to the tow vehicle

_______ g. Illuminates the trailer to improve its visibility and to provide information to other drivers

_______ h. Form the support framework for the boat

_______ i. Provides an extension from the trailer to the tow vehicle to allow adequate clearance between the tow vehicle and the boat during turns

_______ j. Houses the wheels, wheel bearings, and the brakes

1. Hitch
2. Tongue
3. Tongue jack
4. Frame
5. Winch
6. Light system
7. Boat supports
8. Axle
9. Tire-and-wheel assembly
10. Tilt control

2. List the design characteristics used to classify trailers. Write your answers on the blanks provided below.

a. ____________________________________________

b. ____________________________________________

c. ____________________________________________

d. ____________________________________________

3. State guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle. Write your answers on the blanks provided below.

   a. ______________________________

   b. ______________________________

   c. ______________________________

4. Describe the purposes of the trailer bow-stop and tongue-weight adjustments. Write your answers on the blanks provided beside the terms below.

   a. Bow-stop adjustment ______________________________

   b. Tongue-weight adjustment ______________________________

5. List types of trailer brake systems. Write your answers on the blanks provided below.

   a. ______________________________

   b. ______________________________

   c. ______________________________

## Written Test

6. Complete statements about the principles of hydraulic-brake-system operation. Write your answers on the blanks provided in the statements below.

   a. ________________ pressure is used to actuate the trailer brakes.

   b. Power for the hydraulic pump is normally provided by an electrical circuit powered by the tow vehicle's ________________ system.

   c. When the tow-vehicle brakes are applied, ________________ powers the hydraulic pump to move the ________________________________, forcing the brake shoes against the ________________.

   d. When the tow-vehicle brakes are released, power is removed from the ________________________________ and a return mechanism, such as a ________________, pulls the brake shoes back from the ________________.

7. Complete statements about the principles of electric-brake-system operation. Write your answers on the blanks provided in the statements below.

   a. When the tow-vehicle brakes are applied, an ______________________ ________________ is closed so that the vehicle ________________ ________________ come on.

   b. The trailer lighting harness includes a connection between the tow-vehicle ________________ circuit and an ________________ circuit in the trailer brakes.

   c. When the tow-vehicle brakes are applied, the ________________ in the trailer-brake circuit is switched on and a ________________ pushes the trailer's brake shoes against the ________________.

   d. When the tow-vehicle brakes are released, the ________________ in the trailer-brake circuit is switched off and a return mechanism, such as a ________________, pulls the trailer's brake shoes back from the ________________.

8. Complete statements about the principles of surge-brake-system operation. Write your answers on the blanks provided in the statements below.

   a. The tow-vehicle ________________ slow the tow vehicle and, thus, the trailer.

   b. The momentum of the trailer causes the ______________________ ________________ to engage.

   c. When the tow vehicle accelerates, the increase in speed causes the ________________________________ to disengage.

9. List six of the typical service procedures required for trailers. Write your answers on the blanks provided below.

   a. ______________________________________________

   b. ______________________________________________

   c. ______________________________________________

   d. ______________________________________________

   e. ______________________________________________

   f. ______________________________________________

Permission to duplicate this test is granted.

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Unit Evaluation Form

Student name ______________________________ Unit rating ______________

**Assignment-sheet ratings**

**Assignment Sheet 1—**Determine Trailer Specifications and Parts Requirements Rating ________

Comments: ______________________________

______________________________

**Assignment Sheet 2—**Select Trailers for Outboard-Engine Boat Systems Rating ________

Comments: ______________________________

______________________________

**Assignment Sheet 3—**Inspect Trailers Rating ________

Comments: ______________________________

______________________________

**Assignment Sheet 4—**Complete a Boat-Safety Exam Rating ________

Comments: ______________________________

______________________________

**Job-sheet ratings**

**Job Sheet 1—**Perform Routine Maintenance on Trailers Rating ________

Comments: ______________________________

______________________________

**Job Sheet 2—**Repair Trailers Rating ________

Comments: ______________________________

______________________________

## Unit Evaluation Form

**Job Sheet 3**—Safely Tow Outboard-Engine Boats Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 4**—Safely Launch Outboard-Engine Boats Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 5**—Safely Operate Outboard-Engine Boats Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 6**—Safely Load Outboard-Engine Boats Rating ________

Comments: ______________________________________________

______________________________________________

**Written-test scores**

Pretest ________ Posttest ________ Other ________

Comments: ______________________________________________

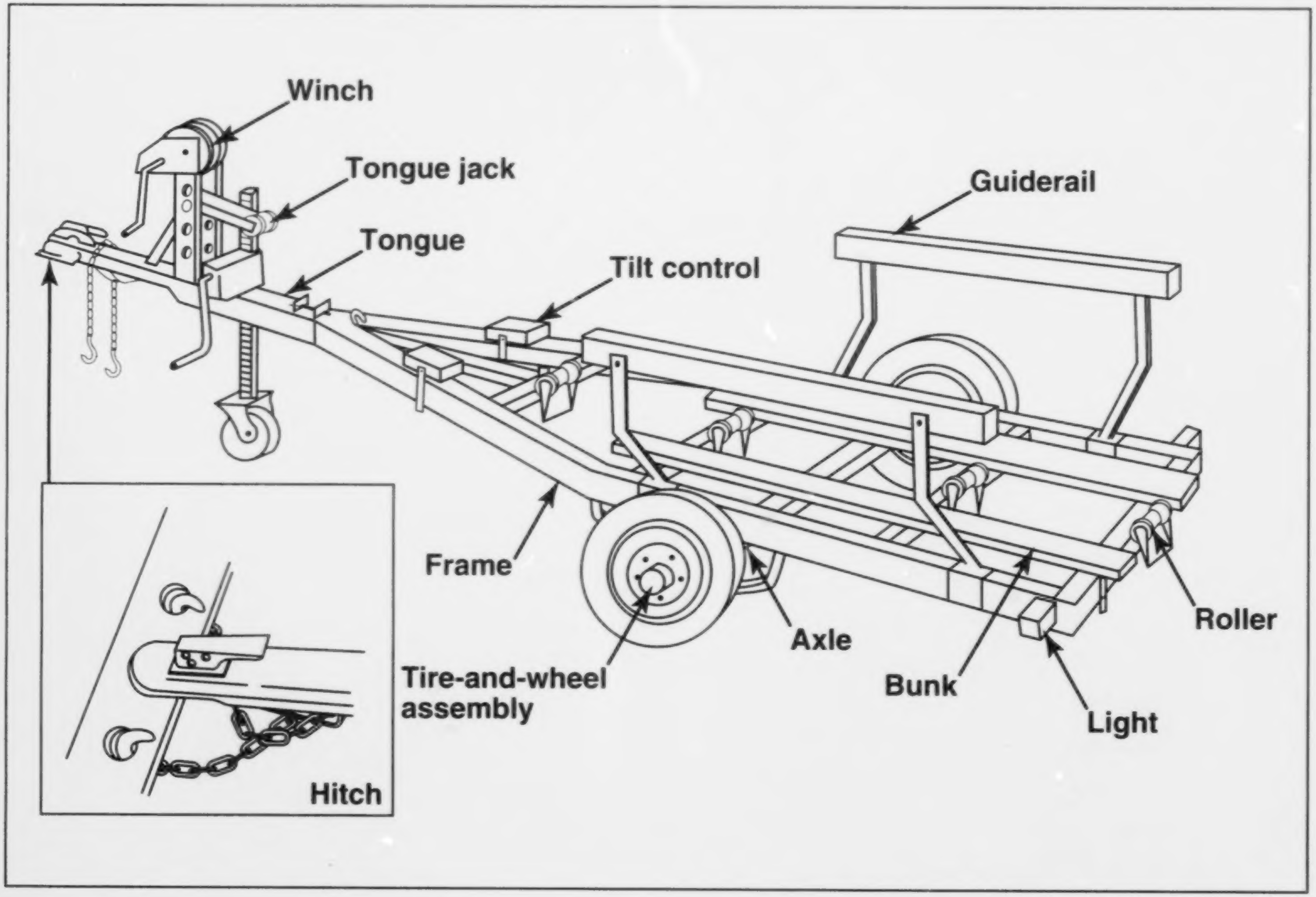
______________________________________________

**Teacher signature** ______________________ Date ____________

**Student signature** ______________________ Date ____________

Permission to duplicate this form is granted.

# Major Components of Trailers


Winch
Tongue jack
Tongue
Tilt control
Guiderail
Frame
Axle
Roller
Tire-and-wheel assembly
Bunk
Light
Hitch

## Job Sheet 1

## Worksheet—Perform Routine Maintenance on Trailers

Name Attempt number

Date

---

**Part A: Pre-performance check**

Job

- Complete the following information concerning the assigned equipment.

  Equipment brand

  Equipment model/type and code

- Complete the following service-manual information.

  Service-manual title

  Section/page number of procedure

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature**

## Job Sheet 1

## Worksheet—Perform Routine Maintenance on Trailers

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

## Job Sheet 2

## Worksheet—Repair Trailers

Name Attempt number

Date

---

**Part A: Pre-performance check**

Job

- Complete the following information concerning the assigned equipment.

  Equipment brand

  Equipment model/type and code

- Complete the following service-manual information.

  Service-manual title

  Section/page number of procedure

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature**

## Job Sheet 2

## Worksheet—Repair Trailers

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

## Job Sheet 3

## Worksheet—Safely Tow Outboard-Engine Boats

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A:** **Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________________

  Type and size of boat and engine ______________________________

  Type of tow vehicle ______________________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned towing procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

Job Sheet 3

## Worksheet—Safely Tow Outboard-Engine Boats

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Procedures completed correctly. | ______ |
| Equipment operated correctly. | ______ |
| Safety precautions observed. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

## Job Sheet 4

## Worksheet—Safely Launch Outboard-Engine Boats

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________________

  Type and size of boat and engine ______________________________

  Type of tow vehicle ______________________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned launching procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 4

## Worksheet—Safely Launch Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Procedures completed correctly. | ________ |
| Equipment operated correctly. | ________ |
| Safety precautions observed. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

---

# Job Sheet 5

## Worksheet—Safely Operate Outboard-Engine Boats

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Type and size of boat ______________________

  Type and size of engine ______________________

- Inspect the boat and engine and describe the results of your inspection.

- Describe conditions on the body of water.

- Describe your planned operation procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 5

## Worksheet—Safely Operate Outboard-Engine Boats

---

**Part B: Performance evaluation**

**Evaluation criteria** **Rating**

Procedures completed correctly. ________

Equipment operated correctly. ________

Safety precautions observed. ________

Clean-up and follow-up actions adequate. ________

**Overall rating** ________

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

## Job Sheet 6

### Worksheet—Safely Load Outboard-Engine Boats

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ____________________________________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________________

  Type and size of boat and engine ______________________________

  Type of tow vehicle ______________________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned loading procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 6

## Worksheet—Safely Load Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

____________________________________________

____________________________________________

# Seasonal Procedures
# Unit 3

## Suggested Activities

### Instructional plan

Preparation

- Review the unit in the student edition and plan your presentation. Study the specific objectives to determine the order in which you will present the objectives.

  Review the unit introduction and teaching suggestions included in the delivery and application section below, and plan classroom activities. Also note suggestions for media and supplemental materials.

  Plan presentation to take advantage of student learning styles and to accommodate special-needs students.

- Prepare the classroom by displaying posters, equipment, and tools related to boat-system seasonal care and storage.

- Select teacher components (written test, unit evaluation form) you want to distribute to your students. Copy and prepare these components for distribution.

- Review the job sheets and worksheets in the student edition and locate the worksheet masters included in the teacher pages of this unit. Copy and prepare extra worksheets for distribution to your students.

Delivery and application

Unit introduction

The skill areas appearing in bold-face type in the unit introduction and teaching suggestions refer to the academic and workplace skills identified in *What Work Requires of Schools: A SCANS Report for America 2000* and *Workplace Basics: The Skills Employers Want*. These have been adapted by MAVCC.

- Provide the students with copies of the student materials. You may choose to begin by discussing the objective sheet. Review the unit and specific objectives with the students. Discuss how meeting the unit objective will improve their employability or will increase their value as an employee. Explain how the specific objectives support the unit objective. **(Listening; adapting to the organization's traditional modes of operation; emphasizing personal and career development)**

- Introduce the unit by having the students discuss how people use boats in your area. Guide the discussion to cover specific practices such as year-round use, in-water storage, on-shore storage, etc. Lead the discussion to speculate on how those procedures might vary in other areas. Provide the students with service manuals that cover seasonal procedures and relate the procedures covered with your discussion. Emphasize procedures used in your area. Discuss the effects of poor seasonal protection on a boat system. **(Listening; reasoning; seeing things in the mind's eye; system interrelationships)**

## Suggested Activities

Teaching suggestions

**Objective 1** Define the seasonal procedures required for outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- State that many boats are stored for the winter. Therefore, winterizing includes those procedures necessary to protect the boat for the winter. Summerizing is simply those procedures to take the boat out of storage and ready it for operation again. Discuss the general purpose and procedures associated with each process. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 2** State the purposes of winterizing outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- Discuss the purposes of winterizing in detail. Provide students with examples of the damage that can occur if an engine is not properly winterized, such as corroded rings, varnish deposits, damage due to freezing, engine and hull exterior damage, etc. Discuss the breakdown of gasoline and use the discussion as an introduction to the next objective. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 3** State the purposes of adding stabilizers when winterizing outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- Display various types of fuel stabilizers and discuss their use. Emphasize service and safety guidelines. Discuss mixing ratios. Discuss the proper disposal of drained gasoline if that option is used. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 4** Define the term *fogging*.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**
- Display rust-preventative oils used for fogging. Discuss their use and the purpose of fogging. Display parts that have not been adequately protected. Relate fogging to the overall winterizing process. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

## Suggested Activities

**Objective 5** Describe the fogging process.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Demonstrate fogging on both carbureted and fuel-injection systems. Discuss the purpose of each step and applicable service and safety guidelines. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships; applying technology)**

**Objective 6** List the typical service procedures required for winterizing outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Demonstrate each of the service procedures performed with winterizing. Emphasize procedures used in your area. Provide examples of tools and materials (paints, lubricants, waxes, etc.) used to winterize a boat system. Discuss service and safety considerations. Describe specific requirements for boats and engines commonly used in your region. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships; applying technology)**

**Objective 7** State the purposes of summerizing outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Relate the purposes of summerizing to the procedures performed for winterizing. Discuss both boat and engine systems and trailer/tow-vehicle systems. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships)**

**Objective 8** List the typical service procedures required for summerizing outboard-engine boat systems.

- Read and discuss with students the information presented in this section of the information sheet. **(Reading/listening for content)**

- Demonstrate the procedures required for summerizing outboard-engine boat systems. Use a variety of boat systems to cover variations in procedures. Discuss the importance of each step, as well as service and safety guidelines. **(Listening; reasoning; seeing things in the mind's eye; interpreting and processing information; system interrelationships; applying technology)**

## Suggested Activities

**Assignment Sheet 1** Determine seasonal-service specifications for outboard-engine boat systems.

- Have students locate Assignment Sheet 1. Read the introduction and directions to the assignment. **(Reading/listening for direction)**

- Make resources available that will allow the students to determine the required information. Tailor the assignment sheet to equipment used in your facility. **(Reading; writing; seeing things in the mind's eye; acquiring, organizing, interpreting, and processing information; system interrelationships)**

- Answer any student questions and have students complete Assignment Sheet 1.

**Job Sheet 1** Winterize outboard-engine boat systems.

- Have students locate Job Sheet 1 and the worksheet associated with the job sheet. Demonstrate the procedures for winterizing outboard-engine boat systems. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with an outboard-engine boat system and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 1.

**Job Sheet 2** Summerize outboard-engine boat systems.

- Have students locate Job Sheet 2 and the worksheet associated with the job sheet. Demonstrate the procedures for summerizing outboard-engine boat systems. Review with students the worksheet associated with the job sheet, and have them obtain copies of the worksheet for each attempt that will be required.

- Provide students with an outboard-engine boat system and have them complete the pre-performance check (Part A) on the worksheet. Evaluate the pre-performance check, and when a student has completed it satisfactorily, have him/her complete Job Sheet 2.

Evaluation

- Evaluate the assignment sheet. See the evaluation criteria listed at the top of the assignment sheet as well as the teacher page "Answers to Assignment Sheet."

- Evaluate the job sheets.

  When the student is ready to perform a specific task, obtain a copy of the worksheet associated with each job sheet. Worksheets may be found in the student edition and in the teacher pages. Then, observe the student performing the procedure.

## Suggested Activities

After the student has completed the procedure, rate the student using the criteria provided on the worksheet. If the student's performance is unacceptable, have the student review the materials and perform the procedure again for evaluation.

Two sample performance evaluation keys are provided below. Many other keys are available. Select one evaluation key (grading scale) that best fits your program needs.

### Performance Evaluation Keys

**Sample A**

4 — Skilled—Can perform job with no additional training.
3 — Moderately skilled—Has performed job during training program; limited additional training may be required.
2 — Limited skill—Has performed job during training program; additional training is required to develop skill.
1 — Unskilled—Is familiar with process, but is unable to perform job.

**Sample B**

Yes—Can perform job with no additional training.

No—Is unable to perform job satisfactorily.

- Give the written test. See the teacher page "Written Test."
- Evaluate the written test. See the teacher page "Answers to Written Test."
- Compile written-test, assignment-sheet, and job-sheet scores. See the teacher page "Unit Evaluation Form."
- Reteach and retest as required.

## Suggested resources

**Resources used in developing this unit**

Print media

- Buchanan, George. *The Boat Repair Manual.* New York: Arco Publishing, Inc., 1985.
- *Everything You Need to Know About Propellers,* 4th ed. Brunswick Corporation, 1992.
- Gladstone, Bernard, and Tom Bottomley. *Boatkeeper: The Boatowner's Guide to Maintenance, Repair, and Improvement.* New York:. Hearst Marine Books, 1984.

## Suggested Activities

- Kendall, Dave. *The Complete Book of Boat Maintenance and Repair.* Garden City, New York: Doubleday and Company, Inc., 1975.
- *Outboard Repair.* Stillwater, Oklahoma: Mid-America Vocational Curriculum Consortium, 1985.
- United States Coast Guard. *Skipper's Safe Boating Course,* 2nd ed. St. Louis, Missouri: Mosby-Year Book, Inc., 1996.

### Suggested supplemental resources

Print media

- *Boating Magazine.* 1633 Broadway, New York, New York 10019, (212) 767-5585.
- *Motor Boating and Sailing.* 250 W. 55th St., New York, New York 10019, (212) 649-4099.
- *Trailer Boats.* Poole Publications, Inc., 20700 Belshaw Ave., Carson, California, (310) 537-6322.
- Service manuals and operator's manuals for systems and equipment covered in this unit. Available from equipment manufacturers.
- Catalogs, brochures, and promotional materials covering accessories and rigging. Available from equipment manufacturers.

Nonprint media

- *Top 60 Tips—Maintenance.* This 45-minute video discusses many aspects of boat maintenance, including hull and hardware care, as well as seasonal procedures suitable to Unit 3. Available from Sea Tow International, 1560 Youngs Ave., Southold, New York 11971, (516) 765-3660, website http://www.boatingsafety.com.

Organizations

- Association of Marine Technicians (AMTECH). An organization dedicated to improving marine service through cooperation, certification, and education. 455 Knollwood Terrace, Roswell, Georgia 30075, (800) 467-0982.
- Boat Owners Association of The United States (BoatUS). Provides publications, resources, information, equipment, and other useful materials with discounts to members. Maintains a helpful website. 880 S. Pickett St., Alexandria, Virginia 22304, website http://boatus.com.
- National Marine Manufacturers Association. A good source of information about trends in watercraft sales and production. 200 E. Randolph Drive, Suite 5100, Chicago, Illinois 60601, (312) 946-6200, website http://www.nmma.com.

**Suggested Activities**

- Nautical Know How, Inc. Sponsors of a useful website that provides state boating quizzes, on-line safety and skills courses, and other resources. 5102 S.E. Nassau Terrace, Stuart, Florida 34997, (888) 297-2076, website http://boatsafe.com.
- United States Coast Guard. Of particular interest is the Office of Boating Safety. Contact the national headquarters or visit their website to obtain information about your nearest facility. (800) 368-5647, website http://www.uscg.mil.
- United States Coast Guard Auxillary. Contact the USCG or visit the Auxiliary website to determine how to contact your local chapter, website http://www.cgaux.org.
- United States Power Squadron. Provides information, quizzes, and materials to promote boat safety. P.O. Box 30423, Raleigh, North Carolina 27622, (888) FOR-USPS, website http://www.usps.org.

# Seasonal Procedures
# Unit 3

## Answers to Assignment Sheet

**Assignment Sheet 1**—Student performance should be evaluated according to the criteria listed on the assignment sheet. The answers will depend upon the equipment selected by the instructor.

# Seasonal Procedures
# Unit 3

## Answers to Written Test

1. a. Those actions taken to protect a boat system from the effects of exposure to low temperatures and other weather conditions during storage

   b. Those actions taken to return a boat system to peak operating condition after it has been stored

2. Answer should include any four of the following.

   - To prevent corrosion of engine parts such as piston rings, cylinder walls, and bearing surfaces
   - To prevent clogged fuel systems due to varnish and other deposits
   - To prevent engine-support-system damage caused by water expansion due to freezing
   - To keep the battery from discharging
   - To reduce boat-system damage due to condensation and low temperatures
   - To prevent boat-system damage caused by exposure to the elements

3. Answers may appear in any order.

   - To delay the breakdown of fuel
   - To eliminate the need to drain the fuel tank during winterizing

4. Process for coating the internal engine parts to prevent rust and corrosion

5. Operate the engine with the lower unit submerged in clean water to provide adequate cooling. Run the engine while injecting rust-preventative oil into the carburetor until the engine smokes excessively.

6. Answer should include any eight of the following.

   - Add stabilizer or drain fuel system
   - Add rust-preventative oil to engine through fogging
   - Remove portable fuel tank
   - Disconnect spark-plug lead
   - Remove and store battery
   - Clean and lubricate propeller shaft
   - Change lower-unit lubricant
   - Touch up paint and finishes
   - Apply protective finish to external surfaces
   - Cover or store boat

## Answers to Written Test

7. Answers may appear in any order.

   - To undo the steps taken to prepare the boat system for storage
   - To restore the engine and boat to peak operating performance
   - To prepare the trailer for safe highway operation and secure transport of the boat

8. Answer should include any six of the following.

   - Check lubricant and other fluid levels
   - Check for fluid leaks
   - Check battery
   - Check engine operation
   - Check warning systems
   - Check lights and running lights on boat and trailer
   - Check trailer tire pressure

## Seasonal Procedures
## Unit 3

### Written Test

Name ______________________________ Score ______________

1. Define the seasonal procedures required for outboard-engine boat systems. Write your answers on the blanks provided beside the terms below.

   a. Winterizing ______________________________

   b. Summerizing ______________________________

2. State four of the purposes of winterizing outboard-engine boat systems. Write your answers on the blanks provided below.

   a. ______________________________

   b. ______________________________

   c. ______________________________

   d. ______________________________

3. State the purposes of adding stabilizers when winterizing outboard-engine boat systems. Write your answers on the blanks provided below.

   a. ______________________________

   b. ______________________________

4. Define the term *fogging*. Write your answer on the blanks provided beside the term below.

   Fogging ______________________________

## Written Test

5. Describe the fogging process. Write your answer on the blanks provided below.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

6. List eight of the typical service procedures required for winterizing outboard-engine boat systems. Write your answers on the blanks provided below.

a. ______________________________________________
b. ______________________________________________
c. ______________________________________________
d. ______________________________________________
e. ______________________________________________
f. ______________________________________________
g. ______________________________________________
h. ______________________________________________

7. State the purposes of summerizing outboard-engine boat systems. Write your answers on the blanks provided below.

a. ______________________________________________
b. ______________________________________________
c. ______________________________________________

8. List six of the typical service procedures required for summerizing outboard-engine boat systems. Write your answers on the blanks provided below.

a. ______________________________________________
b. ______________________________________________
c. ______________________________________________
d. ______________________________________________
e. ______________________________________________
f. ______________________________________________

Permission to duplicate this test is granted.

# Seasonal Procedures
## Unit 3

### Unit Evaluation Form

Student name ______________________ Unit rating ____________

**Assignment-sheet rating**

**Assignment Sheet 1**—Determine Seasonal-Service Specifications for Outboard-Engine Boat Systems Rating ________

Comments: ______________________________________________

______________________________________________

**Job-sheet ratings**

**Job Sheet 1**—Winterize Outboard-Engine Boat Systems Rating ________

Comments: ______________________________________________

______________________________________________

**Job Sheet 2**—Summerize Outboard-Engine Boat Systems Rating ________

Comments: ______________________________________________

______________________________________________

**Written-test scores**

Pretest ________ Posttest ________ Other ________

Comments: ______________________________________________

______________________________________________

**Teacher signature** ______________________ Date ____________

**Student signature** ______________________ Date ____________

Permission to duplicate this form is granted.

## Job Sheet 1

## Worksheet—Winterize Outboard-Engine Boat Systems

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 1

## Worksheet—Winterize Outboard-Engine Boat Systems

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

---

## Job Sheet 2

## Worksheet—Summerize Outboard-Engine Boat Systems

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 2

## Worksheet—Summerize Outboard-Engine Boat Systems

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

# Power Product Equipment Technician:

# Outboard-Engine Boat Systems

## Student Edition

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# *Outboard-Engine Boat Systems*

Student Edition

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# Orientation to Outboard-Engine Boat Systems and Rigging
# Unit 1

## Objective Sheet

### Unit objective

After completing this unit, the student should be able to identify the major components of outboard-engine boat systems and select parts and accessories for, rig, and inspect an outboard-engine boat. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific objectives

After completing this unit, the student should be able to

1. List the characteristics used to classify boat systems.
2. Define the term *outboard-engine boat system.*
3. Match the major components of outboard-engine boat systems to their correct definitions.
4. Define directional terms used for boat systems.
5. Define types of hull conditions and defects.
6. Label common types of hardware used with rigging and accessories.
7. State the purposes of common types of instruments and gauges used on outboard-engine boat systems.
8. State the purposes of common types of electrical accessories used on outboard-engine boat systems.
9. Define common types of corrosion-protection systems.
10. State the purposes of common types of hardware accessories used on outboard-engine boat systems.
11. List the typical procedures performed when rigging outboard-engine boat systems.
12. Determine specifications for selecting and installing outboard engines. (Assignment Sheet 1)
13. Determine specifications and parts requirements for rigging and accessories for outboard-engine boat systems. (Assignment Sheet 2)
14. Inspect outboard-engine boat systems and rigging. (Assignment Sheet 3)
15. Install and adjust outboard engines. (Job Sheet 1)
16. Install and adjust remote engine-control assemblies. (Job Sheet 2)
17. Install and adjust steering systems. (Job Sheet 3)

## Objective Sheet

18. Install tank-to-engine fuel lines. (Job Sheet 4)
19. Install remote oil tanks. (Job Sheet 5)
20. Service and install batteries. (Job Sheet 6)
21. Install and adjust pitot systems. (Job Sheet 7)
22. Install and adjust transducer systems. (Job Sheet 8)
23. Install and adjust instruments and gauges. (Job Sheet 9)
24. Install and adjust electrical accessories. (Job Sheet 10)
25. Install and adjust hardware accessories. (Job Sheet 11)

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Information Sheet

1. **Characteristics used to classify boat systems**

- **Hull type**

  Note: There are two general types of hulls: (1) displacement and (2) planing. With a displacement hull, the boat displaces the same amount of water whether it is moving or at rest. In other words, the portion of the boat that is under water is approximately the same when the boat is moving or at rest. With a planing hull, the boat rises in the water as its speed increases—it displaces more water while at rest than while moving. Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," provides a more-complete discussion of hull types.

- **Hull material**

  Examples: Fiberglass, wood, plywood, aluminum

  Note: Student Supplement 1 provides a discussion of the types of hull materials commonly used on outboard-engine boats.

- **Hull shape**

  Examples: Flat-bottom hull, vee hull, catamaran

  Note: Student Supplement 1 discusses the hull shapes commonly used on outboard-engine boats.

- **Hull size**

  Examples: Length, weight, water displacement

- **Power source**

  Examples: Sails, paddles, propeller, fan

- **Engine configuration**

  Examples: Inboard, outboard, stern-drive

- **Engine characteristics**

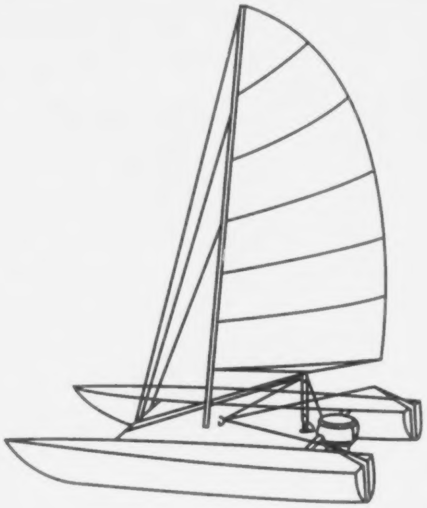
  Examples: Horsepower, number of cylinders, cylinder configuration, type of fuel, type of cooling system

- **Application**

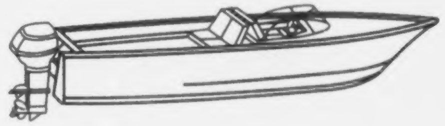
  Note: The term *application* refers to the intended use of a boat. Boats are used as workboats, sailboats, runabouts, cabin cruisers, sport boats, house boats, etc. (See Figure 1 on the next page and Student Supplement 1.)

## Information Sheet

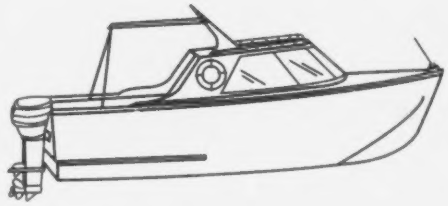
**Figure 1:** Common applications for outboard-engine boats



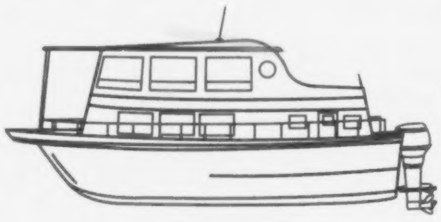
Sailboat



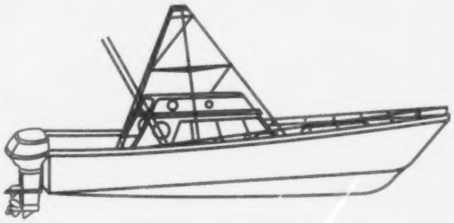
Outboard runabout



Outboard cruiser



House boat



Sport-fishing boat

2. **Definition of the term *outboard-engine boat system***

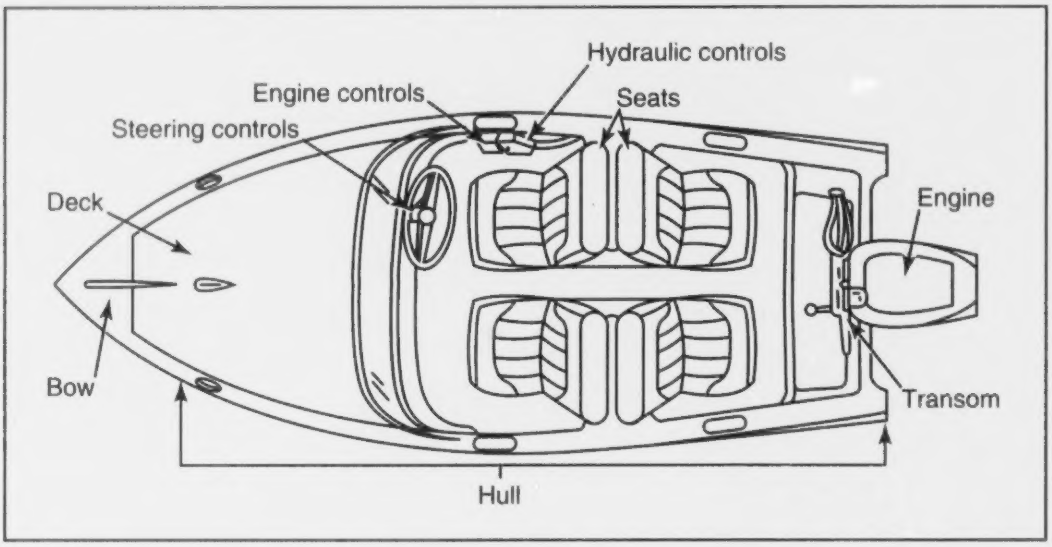
- **Outboard-engine boat system**—System consisting of a boat hull and engine where the engine is normally mounted on the outside of the boat hull (see the illustrations in Figure 1 above and in Figure 2 on the next page)

Note: This course deals with a type of boat system known as an *outboard-engine boat system.* As you learned in Objective 1, the outboard engine is just one type of engine configuration used in boat systems, and engine configuration is just one way of classifying boat systems. Most of the characteristics used to classify boat systems do not exclude each other. For example, a flat-bottom boat made of fiberglass may use an outboard engine with various characterisitics with regard to horsepower, number of cylinders, etc. The outboard-engine technician must be familiar with all the characteristics used to classify boat systems because the operation of an engine depends on its application.

## Information Sheet

3. **Major components of outboard-engine boat systems and their definitions** (see Figure 2)

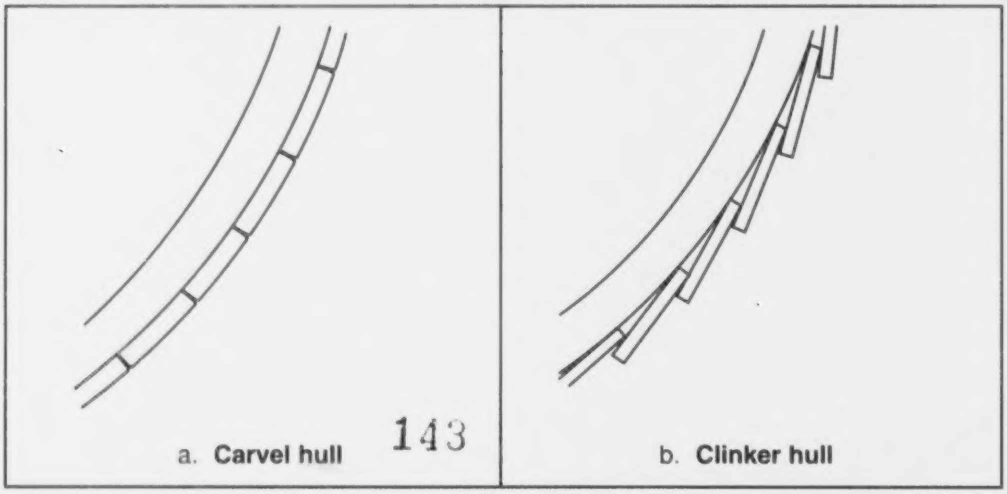
**Figure 2:** Major components of outboard-engine boat systems



- **Engine**—Power source that moves the boat through the water
- **Hull**—Overall structure of the boat that defines its general shape

Note: The hull structure consists of two components: (1) the framework and (2) the skin. Numerous types of framework materials and construction techniques are used to construct the framework, and numerous types of materials are used for the skin. For example, the framework for a wooden hull may be constructed of plywood or wooden planks. If wooden planks are used, they may have flush joints and form what is called a *carvel hull* (see Figure 3-a) or overlapping joints to form what is called a *clinker hull* (see Figure 3-b).

**Figure 3:** Hull structures



a. **Carvel hull**

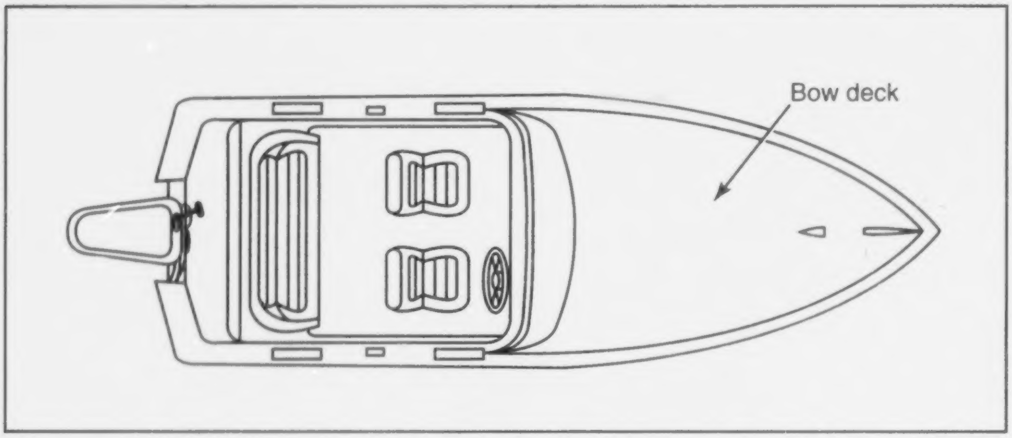
b. **Clinker hull**

### Information Sheet

- **Bow**—Front portion of the hull that cuts through the water as the boat travels forward
- **Deck**—Horizontal surfaces that form the enclosures in the hull

  Note: Small boats seldom have decks. Slightly larger boats may have what is called a *bow deck* (see Figure 4), which covers the front section of the boat to provide reinforcement and to reduce the amount of water that enters the boat. Still larger boats may have an upper and lower section created by a deck that serves as the floor of the upper section and the ceiling of the lower section.

  **Figure 4:** Bow deck



- **Transom**—Rear of the hull that provides a structure for mounting the engine

  Note: Transoms in outboard-engine boat systems are specifically designed to provide a secure and efficient means of mounting the engine. The mounting area may be as simple as a reinforced section with flat surfaces to accommodate the clamps that hold the engine in place, or it may have more-complicated interfaces for electrical and hydraulic systems.

- **Engine controls**—Components that allow the operator to adjust functions such as engine speed, choke-valve setting, and gear ratio

  Note: Engine controls for outboard-engine boat systems may be located on the engine or may be remote from the engine. For example, an outboard engine may have a rope-rewind starter, or it may have an electric starter with a key or pushbutton switch that is located forward of the engine. The engine speed may be set by the operator's adjusting a slide knob on the engine or by moving a throttle lever in a forward section of the boat. Many boats with remote engine-control systems provide a dashboard with gauges, switches, and controls similar to those in an automobile.

- **Hydraulic controls**—Components that allow the operator to raise and lower the engine

  Note: In order to protect the engine during loading, unloading, and trailering and when boating in shallow water with submerged obstacles, most outboard engines are mounted so that the engine can be tilted to raise or lower the normally submerged portion of the engine. The operator may perform this operation manually or with the use of hydraulics.

## Information Sheet

- **Steering controls**—Components that allow the operator to change the direction of boat travel

  Note: In its simplest form in an outboard-engine boat system, steering is accomplished by the operator's using a handle to pivot the engine. More-complex steering systems use cables or hydraulics to make the engine pivot.

- **Seats**—Places for the passengers and operator to sit

- **Accessories**—Components that support the operation of the boat system without being essential to the function or control of the engine and steering system

  Examples: Horn, entertainment equipment, communication equipment, etc.

- **Rigging**—Configuration of the attachments made to a boat

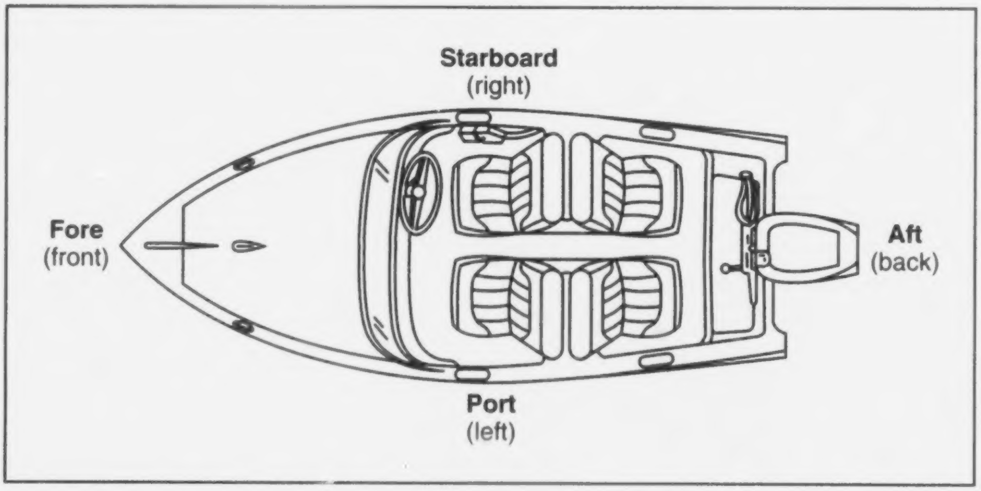
  Note: Originally, the term *rigging* was used to refer to ropes, hardware, and sails of a sailing ship. When applied to outboard-engine boat systems, the term now is used to refer to the mounting of the engine, to the installation of the tie-downs and other hardware, etc.

4. **Directional terms used for boat systems and their definitions** (see Figure 5)

Note: The following terms are relative to the front, back, right, or left of a person facing forward at the midpoint of a boat.

- **Fore**—Front
- **Aft**—Back
- **Starboard**—Right
- **Port**—Left

**Figure 5:** Directional terms



## 5. Types of hull conditions and defects and their definitions

Note: Boat conditions affect boat performance. The technicians who service engines are often called upon to provide additional service to other boat systems, including the hull. Technicians must recognize these defects and understand their impact on boat performance even if they are not engaged in the actual repair of such defects. The technician must also realize hull shapes may be intentional, such as a slight hook to reduce rhythmic bouncing.

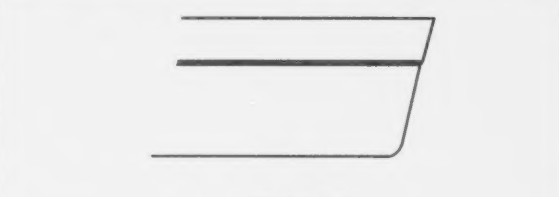
- **Hook**—Condition of the hull in which the center portion of the hull has been bent or has warped above its original contour (see Figure 6-b)

  Note: Also referred to as *hogging,* hooks result from running aground or from weak supporting members that draw up with age or exposure to the elements. This condition may also result from a boat being stored or trailered without adequate support.

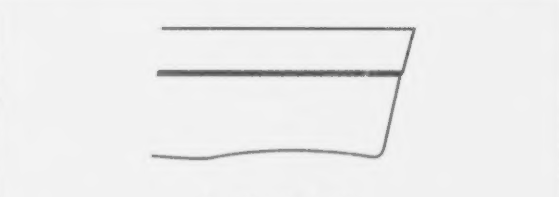
- **Rocker**—Condition of the hull in which the center portion of the hull has bent or warped below its original contour (see Figure 6-c)

  Note: Also referred to as *sagging,* rockers result from swelling or warping of the hull members.

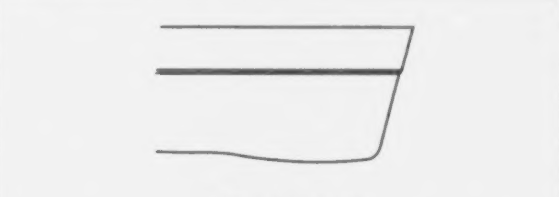
**Figure 6:** Hook and rocker hull conditions



a. **Flat hull**



b. **Hook hull**

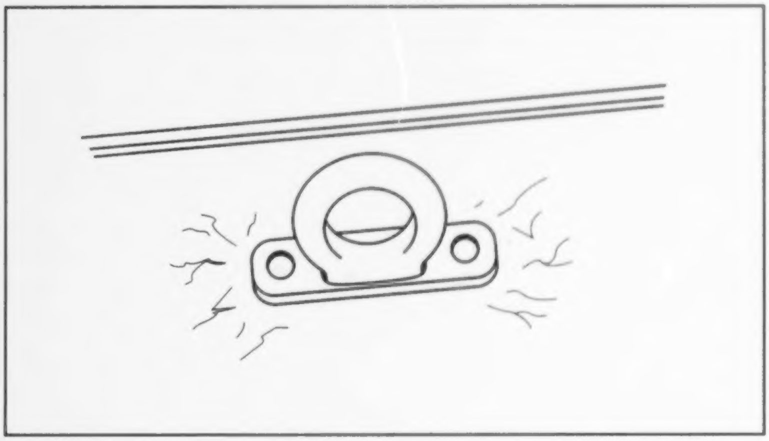


c. **Rocker hull**

## Information Sheet

- **Crazing**—Fine cracks that form in fiberglass hulls and other fiberglass components (see Figure 7)

**Figure 7:** Crazing



- **Fouling**—Deposits on the outside of a boat hull

Note: *Fouling* is a general term for deposits on the surface of a boat hull. Fouling includes barnacles and other marine life, mineral deposits, corrosion, etc.

Barnacles and other marine creatures float about in bodies of water—especially saltwater—in search of a surface to which they can attach. Such surfaces include submerged portions of boat hulls. A hull that is coated with barnacles loses its designed streamlining and increases in weight. These changes affect boat performance.

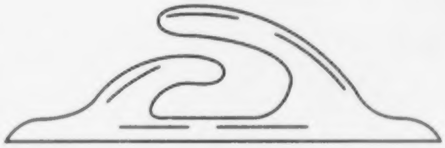
The combining of substances during chemical reactions can lead to the formation of solids or the deterioration of boat surfaces or both. As a general term, *corrosion* is a type of fouling and includes many forms of oxidation, such as rust.

- **Rot**—Decomposition of the hull due to the action of bacteria or fungus

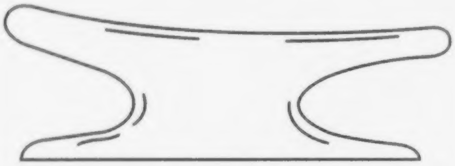
Note: A wet environment promotes the growth of bacteria and fungus. These agents can spread through wood and other materials used in boats. There are two types of rot: (1) dry rot and (2) wet rot. Dry rot is an internal decay that may not be apparent on the outside of wood; wet rot thrives in conditions where the wood is submerged or frequently wet and maintains a wet appearance.

6. **Common types of hardware used with rigging and accessories** (see Figure 8)

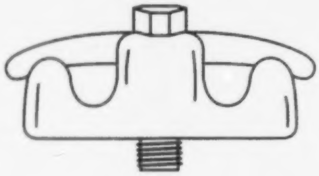
**Figure 8:** Common types of hardware



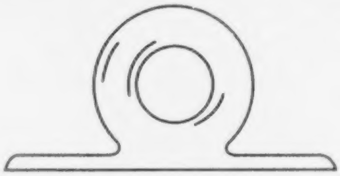
a. **Tie-down**



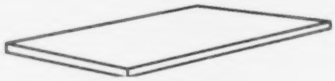
b. **Cleat**



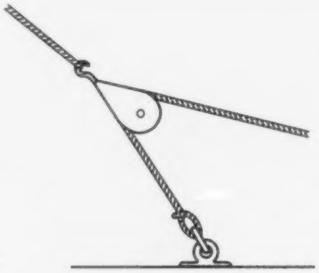
c. **Clamp**



d. **Cable guide**



e. **Shim**



f. **Pulley**

7. **Common types of instruments and gauges used on outboard-engine boat systems and their purposes**

- **Fuel gauge**—Indicates the amount of fuel in the fuel tank (see Figure 9-a on the next page)
- **Ammeter**—Indicates whether the charging system is providing output (see Figure 9-b on the next page)
- **Engine-temperature gauge**—Indicates the temperature of the engine coolant or an overheat condition
- **Water-pressure gauge**—Indicates the output pressure of the cooling-system pump
- **Speedometer**—Indicates the speed of the boat over the water (see Figure 9-c on the next page)

Note: Measuring the speed of a boat is not like measuring the speed of a land vehicle. Many small boats use a pitot system to indicate approximate speed. The pitot measures the pressure of water on an air chamber within an enclosed tube and provides an electrical current to the speedometer from a transducer.

## Information Sheet

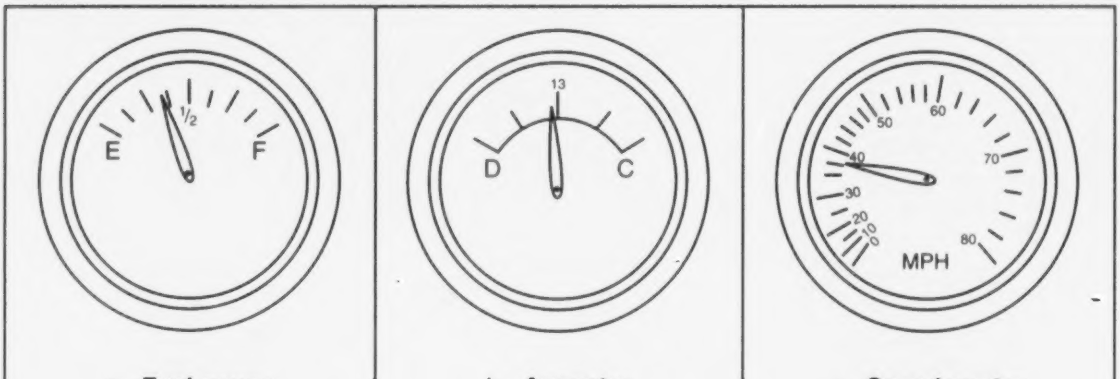
- **Tachometer**—Indicates engine speed (see Figure 9-d)
- **Trim gauge**—Indicates the angle or position of the trim
- **Oil gauge**—Indicates oil pressure or oil-tank level or low oil levels (see Figure 9-e)

  Note: The oil gauge or warning light for a four-stroke-cycle engine generally indicates the oil pressure or provides a warning when oil pressure is low. For two-stroke-cycle engines, oil gauges are generally used only with systems that have remote oil tanks that automatically mix oil with the fuel.

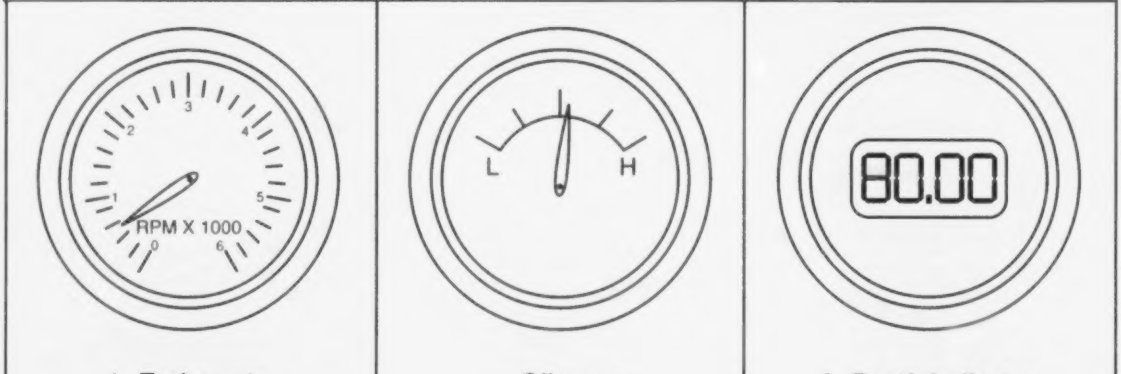
- **Depth indicator**—Indicates underwater features (see Figure 9-f)

  Note: Depth indicators, fish locators, and other devices are used to identify features below the boat. Most of these instruments function by sending sound waves down and measuring the reflection of those sound waves in a simple sonar system. These instruments are useful in measuring the depth of water, identifying underwater obstacles, and locating schools of fish.

**Figure 9:** Types of instruments and gauges



a. **Fuel gauge** b. **Ammeter** c. **Speedometer**



d. **Tachometer** e. **Oil gauge** f. **Depth indicator**

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### 8. Common types of electrical accessories used on outboard-engine boat systems and their purposes

Note: Boats with electrical systems often take advantage of this power source to operate electrical accessories. Some of the most popular are described below.

- **Horn**—Warns other boaters of the presence of the boat
- **Bilge pump**—Removes water that has splashed or leaked into the boat

  Note: It is almost impossible to keep water out of a power boat, even if it does not leak. Swimmers, skiers, fish, and equipment bring water into boats. Wakes from other boats, rain, splashing water, and other circumstances cause water to come into the boat. Large amounts of water—called *bilge*—need to be removed because the water increases the weight of the boat, presents slipping dangers, and can cause damage to equipment and instruments. Bilge pumps are used to remove this water, and many bilge pumps in smaller boats are powered by electricity.

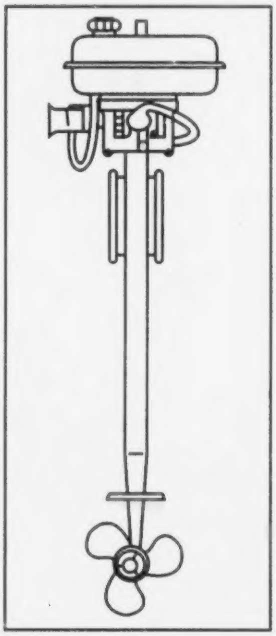
- **Running lights**—Indicate the location and orientation of the boat to other boaters

  Note: Running lights generally are color coded to indicate the fore and aft of the boat and the port and starboard sides of the boat.

- **Trolling motor**—Provides low-speed operation of the boat

  Note: Trolling motors drive the boat at low speeds to allow anglers to search for good fishing locations while trailing lures or bait. A trolling motor may be a small gasoline engine, such as the one shown in Figure 10. Many trolling motors are generally electrically powered and often use a battery separate from that used for other boat electrical systems.

**Figure 10:** Trolling motor



## Information Sheet

- **Entertainment equipment**—Provides audio and video entertainment to boat passengers

  Examples: AM/FM radios, tape players, compact-disc players, televisions

- **Communications equipment**—Provides voice or electronic data exchange between boats or between the boat and land-based facilities

  Examples: Radios, telephones

- **Navigational equipment**—Allows the boat operator to determine the position of the boat and the position of other features relative to the boat

  Note: Radar, geophysical positioning systems using satellites, land-based signal systems, and other types of equipment can be used to determine the position of the boat or can locate other objects, such as land or other boats. Small watercraft—especially those that navigate large bodies of water—often use navigational equipment powered by electricity.

### 9. Common types of corrosion-protection systems and their definitions

Note: When dissimilar metals are brought together in the presence of an acid, a flow of electricity develops. This is the basic principle behind a lead-acid battery, and the process generally occurs with outboard-engine boat systems. The metal of the boat and metal of the engine are often different substances and many bodies of water have dissolved minerals that make them slightly or even highly acidic, especially saltwater. This electrical flow is simply the movement of electrons from one part of the electrical circuit to another. The two poles of the circuit are referred to as the *anode* and the *cathode*, the positive and negative poles, respectively. In an electrolytic circuit, the anode gives up electrons, a process that eventually leads to the breakdown of the material. To prevent damage to the boat and engine, many boat systems are equipped with corrosion-protection systems, such as those described below.

- **Sacrificial anode**—Disposable component that is usually mounted to the engine and is designed to deteriorate more easily than more-important components

  Note: Sacrificial anodes are passive devices—they use no power and simply serve as a source of electrons in the corrosive environment. Often the sacrificial anode will be a trim tab made of aluminum or zinc. Transom tabs and other hardware attachments may also be used as sacrificial anodes.

- **Anodic kit**—Plate mounted to the transom and electrically interconnected to allow electrical flow that deteriorates the plate

- **Galvanic isolator**—Electrical device that is wired into the boat's electrical grounding system to block galvanic flow when a boat is connected to a land-based power source

  Note: The galvanic isolator ensures proper grounding of the electrical system without allowing that system to become part of galvanic flow.

- **Cathode system**—Solid-state controller system that applies battery power to a set of external electrodes to ensure electrical flow to immersed metal requiring protection

  Note: Cathode systems adjust current flow to provide the required level of electrical flow to offset corrosion. The system draws a minimal drain on the battery and has no sacrificial parts.

## Information Sheet

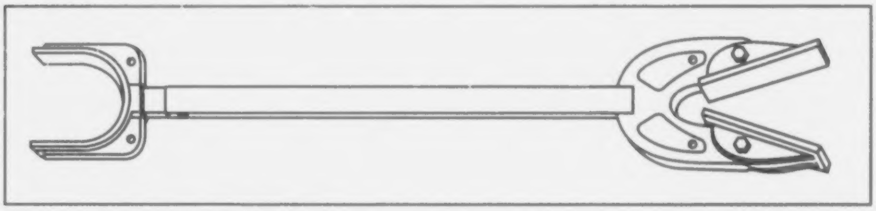
### 10. Common types of hardware accessories used on outboard-engine boat systems and their purposes

Note: Numerous types of hardware equipment can be added to a boat to make it more convenient or safer or to change its performance characteristics. Some of the more-common types are discussed below.

- **Transom savers**—Holds the engine away from the transom during transport and storage (see Figure 11)

  Note: Transom savers are braces that are normally adjustable; they hold the engine away from the transom to keep the engine from bumping the transom and exerting pressure on it during transport.

  **Figure 11:** Transom saver



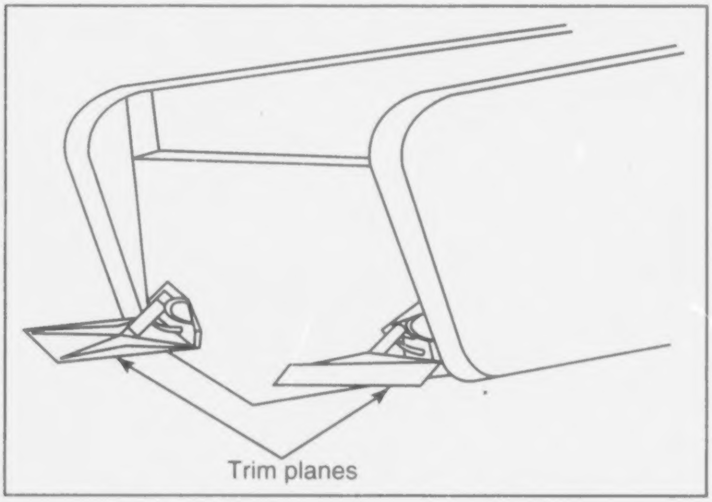
- **Jack plates**—Raise and lower the engine vertically to change the transom height in order to improve acceleration, speed, and fuel economy

  Note: Jack plates are hydraulic controls that are used in conjunction with the trim system to position the engine for optimal operation with changing speeds.

- **Trim planes**—Supplement power trimming of the engine

  Note: Trim planes are plates mounted to the transom in pairs (one on each side of the engine). They are also referred to as *after planes* or *trim tabs*.

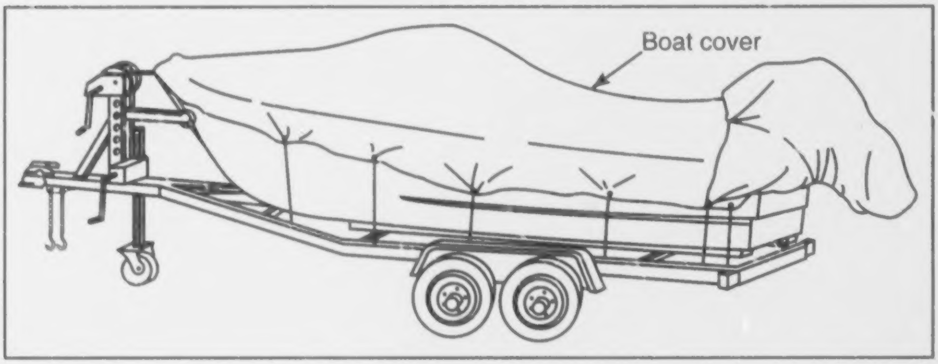
  **Figure 12:** Trim planes



## Information Sheet

- **Boat covers**—Protect the boat from water, sun, and other environmental conditions (see Figure 13)

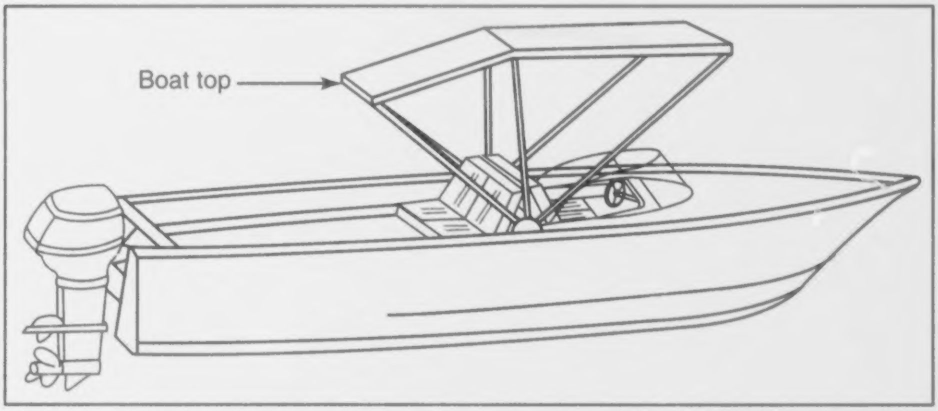
**Figure 13:** Boat cover



- **Boat tops**—Protect the passenger area of the boat

Note: Boat tops are basically roofs for the passenger area of the boat. They generally are metal frames that support canvas or fiberglass (see Figure 14).

**Figure 14:** Boat top



## 11. Typical procedures performed when rigging outboard-engine boat systems

Note: Boat manufacturers produce hulls. These hulls may be completely bare or they may be fully rigged at the factory. Outboard-engine boat systems seldom come from the factory with engines installed. Often this job is done by the local boat dealer. Dealers may install engines on boats to offer complete units or they may allow the customer to select a hull and an engine and then install the engine. Frequently, boat buyers want additional equipment and conveniences added to their boats. While the exact rigging for a boat generally depends on how the boat is to be used and what the customer wants and is willing to pay for, the following are some of the more-common procedures required when rigging a boat.

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- **Install and adjust outboard engine**

  Note: The engine must be installed and securely mounted to the boat. Most engines come with mounting clamps that will fit most boats. However, in some applications, it may be necessary to replace the standard mounting hardware with some that will fit the boat exactly. Engines are designed for standard mounting heights to ensure that the propeller rides below the surface of the water. To obtain the proper mounting height, it may be necessary to use an extension kit on an engine for specific installations. It may also be necessary to adjust the position of the engine laterally along the transom in order to offset engine torque and obtain a true course.

- **Install and adjust remote engine-control assembly**

  Note: There are four common types of remote engine controls. They include (1) throttle control, (2) shift control, (3) tilt and trim controls, and (4) starting controls. Control assemblies are available that offer all of these functions in an integrated unit, or separate assemblies may be used for each. Often throttle and shift controls are combined, and tilt and trim are frequently included in a single control unit. Remote starting is usually provided as a button or key switch as on a car. Installation of a remote starting system may include the installation of an electric starter on the engine and a battery and charging system. Control assemblies may offer other functions, such as carburetor choking. Remote throttle, shift, and tilt and trim controls commonly use cable linkages that must be properly routed and installed with the proper slack to ensure that a particular movement of the control lever results in the desired amount of adjustment in the engine.

- **Install and adjust remote steering system**

  Note: There are numerous types of remote steering systems. Selection of the proper one will be based on the customer's preferences and the recommendations of the boat manufacturer and steering-system manufacturer. The primary concern is that the system provide easy control for the operator and good response in pivoting the engine. The technician must use a minimal amount of mechanical linkage, such as cabling, and install it so that the engine pivots equally in each direction without binding. The neutral position of the steering wheel or other steering control should provide a straight-line course in calm waters, though the neutral position may be slightly trimmed to offset engine torque.

- **Install tank-to-engine fuel line**

  Note: If the boat is equipped with a remote fuel tank, the fuel line will have to be connected to the engine when it is mounted. Some boats will have a fuel line while others will require that one be installed. Outboard-engine service technicians are often required to install the fuel tank also.

- **Install remote oil tank**

  Note: Because it is inconvenient and messy to mix oil in the fuel of two-stroke-cycle engines, many boat operators prefer to have an oil-injection system that will add oil to the fuel automatically, especially if the engine has an external fuel tank. The tank should be installed in accordance with the manufacturer's instructions and adjusted to ensure delivery of oil at the proper ratio.

## Information Sheet

- **Install and service battery**

  Note: As noted above, boat systems equipped with electric starters generally require that the boat provide battery power. Boats that have other electrical equipment, such as communications and navigation equipment, lighting, and entertainment equipment, often have a second battery separate from the starting system that is used to power electrical accessories. If two batteries are used, the boat may include a system for isolating the batteries from each other electrically.

- **Install and adjust pitot system**

  Note: Pitot systems monitor the rate at which water passes through a tube as the boat travels over the water. The principal use of pitot systems in boats is to measure the speed of the boat. The pressure of the water is converted into another energy form, such as using a transducer to drive a speed indicator. The pitot system must be installed so that the induction tube has unobstructed capture of water through which the boat is passing without danger of damage or clogging.

- **Install and adjust transducer system**

  Note: Transducers convert energy from one form to another. For example, a stereo speaker is a transducer that converts electrical energy and often magnetic pulses into mechanical vibrations. Certain instruments and equipment used on boats use transducers to convert mechanical energy into electricity or electricity into mechanical energy. Pitot systems are often tied to transducers to provide an electrical output to instruments such as speedometers.

- **Install and adjust instruments and gauges**

  Note: Boat systems may include many of the same gauges and instruments found on cars, including speedometers, ammeters, oil-pressure indicators, fuel gauges, etc. Additionally, boats are often equipped with special instruments related to navigation, communication, and marine safety. For example, boat instrumentation may include compasses, water-depth indicators, fish locators, anemometers for measuring wind speed, and barometers to measure barometric pressure, just to name a few.

- **Install and adjust electrical accessories**

  Note: Outboard-engine boat systems, especially larger ones, are likely to include a variety of electrical accessories. Houseboats in particular are likely to include a number of electrical conveniences, such as lighting systems, fully equipped kitchens, heating and cooling systems, entertainment centers, water heaters, bilge pumps, and other devices driven by electricity.

- **Inspect boat systems and rigging**

  Note: In addition to being able to rig boat systems, outboard-engine technicians frequently must be able to determine if accessory items are properly installed and operating. As with all devices, boat rigging functions poorly if not properly maintained. Because of the harsh elements and jarring vibrations that boat systems are likely to face, the need to verify proper mounting and installation is just as important as the need to ensure that the equipment operates as intended.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

## Student Supplement 1—Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications

### Introduction

The major portion of a boat is called the *hull*. There are many hull designs, with the variations intended to address specific uses for the boat. In the field of marine technology, technicians are likely to encounter numerous hull designs. There are three main ways for classifying hulls. These include (1) the way the hull rides in the water (displacement), (2) the construction of the hull, and (3) the shape of the hull. This supplement describes many of the hull designs commonly used with outboard-engine boats.

### Displacement/ planing

When a solid object floats in water, a portion of the object is usually below the surface of the water. That part of the object displaces water. The object will float as long as the weight of the displaced water is greater than the weight of the object. For an object at rest, the object's weight is the major factor. For a moving object, part of the object's weight is redirected away from the water with its motion. This is the reason that a stone that would normally sink can skip across the surface of a lake. This action of quickly riding over the surface of water is referred to as *planing*.

### Hull type

**Displacement hulls.** These same terms are used to describe how boat hulls are designed to ride in the water. A displacement hull is one in which a large portion of the hull sinks below the surface of the water. In other words, it displaces a large volume of water and, thus, a considerable amount of weight. Displacement hulls are used for boats that move relatively slowly and that are capable of carrying heavy loads. All large ships, including ocean liners and battleships, have displacement hulls. Outboard-engine boat systems that use displacement hulls tend to be slower moving and to be designed to carry more weight, such as barges, tour boats, and houseboats.

**Planing hulls.** Sport boats, race boats, ski boats, and many small fishing boats are designed to travel over the surface of the water quickly during at least a part of their voyage. Such hulls must ride as close to the surface as possible in order to reduce the drag or resistance of the water. In reality, all boat hulls are basically displacement hulls at rest and at low speeds. However, planing hulls are specifically designed so that increased speeds will cause them to ride higher in the water until, in some designs, the boat is actually just skimming the surface of the water.

### Hull material/ construction

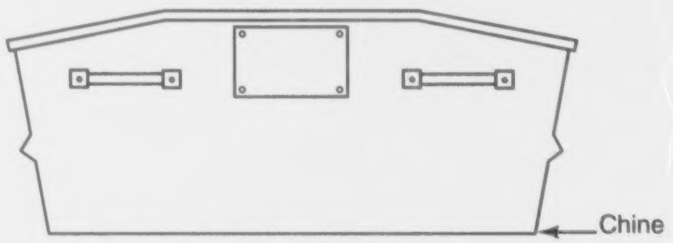
Boat hulls can be made of a number of materials. Those most commonly used for outboard-engine boat systems include (1) metal (usually aluminum), (2) fiberglass, (3) wood for rigid craft, and (4) rubber for inflatable craft. Metal boats generally have what are called *integrated frames*—the metal is shaped or reinforced so that the boat will have adequate strength to hold its shape in normal usage. Fiberglass boats may have integrated frames or a separate frame, such as a canoe with a wooden frame over which fiberglass matting is applied. Wooden boats usually have wooden frames consisting of a central beam or keel along the bottom and ribs rising up from the keel to which the sides of the hull are attached. The two most-common types of wood used for the sides of boat hulls are plywood and wooden planks. When planks are used, they may be installed with the edges flush with each other to form a carvel hull or with an overlap along one edge to form a clinker hull. Carvel hulls are generally easier to work into the curved lines of some hull shapes but may not be as strong or watertight as a well-made clinker hull.

### Hull shape

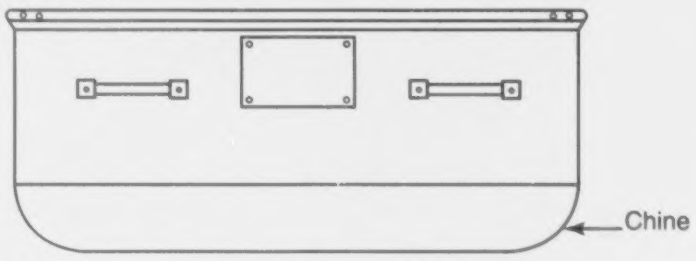
The shape of the hull is primarily determined by its use, including whether the hull is basically a displacement or planing hull. Some of the more-common types are described below.

**Flat-bottom hull.** The bottoms of some boats are essentially level from side to side. Boats with flat-bottom hulls are generally slow and are used for trolling, tour boats, barges, and other boats that do not require rapid travel. The two common designs of flat-bottom hulls are shown in Figure 1: (1) flat-bottom hull with hard chines (see Figure 1-a) and (2) flat-bottom hull with soft chines (Figure 1-b). The two can be distingushed from each other by whether the joint between the sides and bottom—called the *chine*—forms an angle or a curve.

**Figure 1:** Types of flat-bottom hulls



a. **Flat-bottom hull with hard chines**

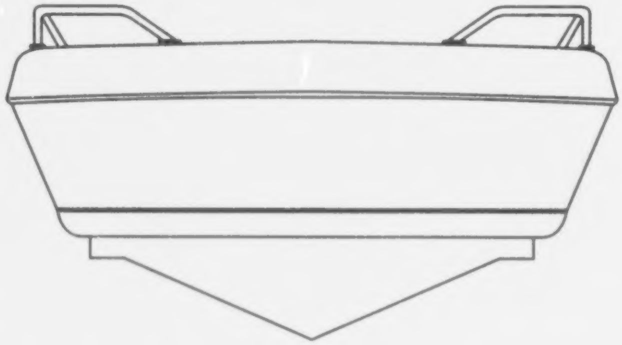


b. **Flat-bottom hull with soft chines**

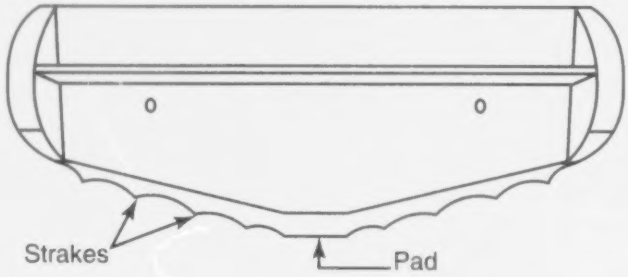
## Student Supplement 1

**Vee-bottom hull.** Many boats taper from the chines to the keel to form an angle at the lowest point of the boat (see Figure 2-a). This vee-shape allows the boat to plane as speed increases. Thus, vee-bottom hulls are used for sport boats and ski boats. Vee-bottom hull designs can vary slightly to improve speed or to provide a smoother ride. One method of making the boat ride higher in the water and flatter across the surface is the use of components called *strakes* (see Figure 2-b). Strakes are narrow ridges that run along the length of the hull or part of its length. The increased planing produced by strakes results in harder contact between the boat and the surface of the water and, thus, a rougher ride. To soften the ride while still increasing the degree of planing, boat manufacturers will use different numbers of strakes or will begin the strakes farther back on the hull. This same effect is sometimes achieved by making a portion of the keel area flat to form what is called a *pad* (see Figure 2-b).

**Figure 2:** Types of vee-bottom hulls



a. **Vee-bottom hull**



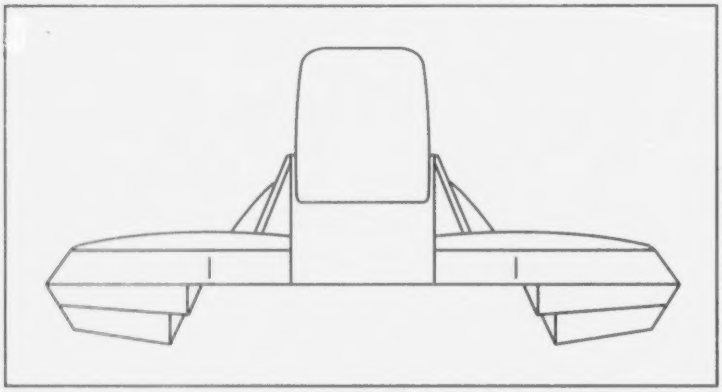
b. **Vee-bottom hull with pad and strakes**

## Student Supplement 1

**Tunnel hull.** One objection that boaters have with vee-bottom boats is that they are less stable from side to side than flat-bottom boats, especially as the boat rises from the water at higher speeds. To improve stability, many hull designs increase the amount of hull volume along the chines. But, to keep resistance down, the volume of the center of the hull is reduced. This results in a boat with good stability that can also travel at high speeds.

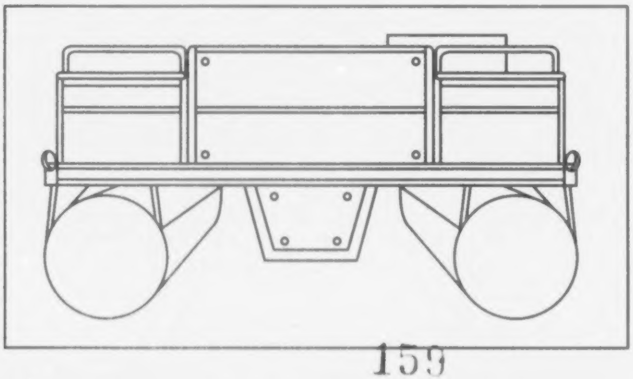
A true tunnel design, such as that shown in Figure 3, is used primarily for racing boats. It may have sharp angles and ridges similar to strakes to assist planing. The fact that the middle portion is hollow makes for a soft ride because the bottom of the boat is not slamming into the water and waves. The enlarged sides of the hull provide stability even in sharp, high-speed turns.

**Figure 3:** Tunnel hull for race boats



**Pontoon.** A similar effect can be accomplished by using pontoons. Pontoons are tanks, generally made of a metal such as aluminum. These metal tanks support the boat deck. In most designs, a pontoon is installed along each outside edge of the boat. The pontoons provide good stability and reduced resistance because of the open space between them. While stability is the major effect of the pontoons, planing of the pontoon hull can be improved by streamlining the noses of the pontoons. Pontoon boats offer a flat, highly usable deck, suitable for houseboats.

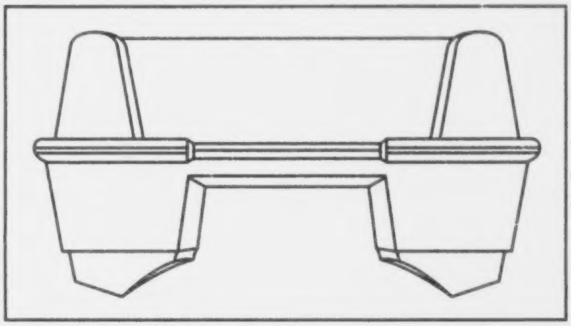
**Figure 4:** Pontoon boat



## Student Supplement 1

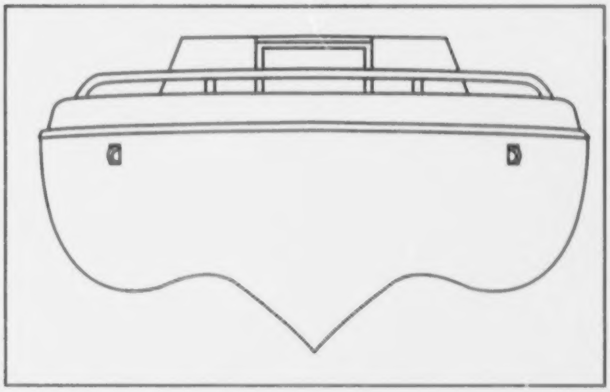
**Catamaran.** A catamaran is similar to a pontoon design except that the hull generally provides the deck, tunnel opening, and buoyant bodies in an integrated hull (see Figure 5). Catamarans are often equipped with sails, even those with outboard engines. They are best suited for lower-speed cruising.

**Figure 5:** Catamaran



**Cathedral hull.** The cathedral hull, or tri-hull, tries to capture the advantages of both vee-bottom hulls and the improved stability of tunnel designs. These designs generally have a vee-bottom keel but are enlarged along the chines. While this design provides good stability, less speed is attainable and the ride can be rough in choppy water. The cathedral hull is most often used for larger cruisers and family fishing boats, though some ski boats use the design.

**Figure 6:** Cathedral hull



**Applications**

The intended use of a boat will affect the choice of hull, of engine, and of how the boat is rigged. For example, an outboard-engine boat system that is intended primarily to be used for deep-sea fishing is likely to have a larger displacement-type hull in order to accommodate passengers and equipment and to perform better in rough seas. The boat will use one or more engines to provide horsepower in excess of 75 horsepower and be equipped with low-pitch propellers (11 to 13 inches). The deep-sea fishing boat will be rigged with chairs, tie-downs, rod-holders, canopies, etc., that will make fishing more convenient and comfortable. It will have communications, navigation, and safety equipment to support venturing far out from shore in potentially rough waters.

The table in Figure 7 lists some of the more-common outboard-engine boat applications and the types of hulls, engines, propellers, and special rigging that may be included on outboard-engine boat systems configured for that use.

**Figure 7:** Common outboard-engine boat applications

| Boat type/application | Hull design | Engine hp | Propeller pitch/ aluminum stainless steel | Special rigging |
|---|---|---|---|---|
| **Workboats**—Boats used for basic transportation and fishing | Flat-bottom inflatable, wood, or aluminum, often with slightly exposed keel | Less than 30 | 11-13<br>Not generally used | Basic seats, swivel seats, transom savers, oar locks |
| **Sailboats**—Boats with sails and engines for harbor cruising and windless conditions | Displacement with large keel or catamaran in wood or fiberglass | 4-25 | 11-13, often with high reverse thrust<br>Not generally used | Rigging for mast and sails, rudders, center-offset engine-mounting hardware |
| **Runabouts**—Boats used for faster transportation, fishing | Vee-bottom, usually fiberglass | 40-70 | 12-19<br>12-16 | Padded seats, swivel seats, external fuel tanks, steering |
| **Recreational boats**—Ski boats, cruisers up to 19 feet in length, fishing boats | Fiberglass or wood vee-bottom, cathedral hulls, some aluminum pontoon hulls | 40-115 | 17-21<br>16-22 | Ski rigging, seats, instrumentation, external fuel tanks, steering |
| **Barges**—Tour boats, transports | Flat-bottom or pontoon, wood or aluminum | 75-115 | 11, 13<br>10, 12 | Canopies, tie-downs |
| **Cabin cruisers**—Boats used for longer trips, deep-sea fishing | Fiberglass or wood vee-bottom or cathedral 19-27 ft | 75-115 | 13, 15<br>14, 16 | Virtually any convenience or comfort feature |
| **Sport boats**—Boats used for racing, faster transportation | Fiberglass high-planing vee-bottom or tunnel bottom | 60-115 | 23 and higher<br>24 and higher | External fuel tank, steering and controls, instrumentation |
| **Houseboats**—Boats used as residences and for frequent overnight stays | Flat or shallow vee-bottom in wood or fiberglass or aluminum pontoons | 60-115 | 11-15<br>12-16 | Virtually any convenience or comfort feature |

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

## Student Supplement 2—Guidelines for Rigging Outboard-Engine Boat Systems

### Introduction

All of the accessories that can be added to a boat hull, including the outboard engine, make up what is called the *rigging*. These include the equipment used for starting, controlling, steering, and monitoring the engine; the equipment used for providing for the passengers' comfort and safety; the equipment used for communicating with others; the equipment used for navigating the boat; and the equipment used for equipping the boat for specific uses, such as skiing or fishing. This supplement discusses some of the general guidelines for rigging a boat and some specific guidelines about certain equipment. It is important that the technician understand and follow these guidelines because rigging a boat system carries liabilities with it. An improperly installed component may not operate correctly. Furthermore, a component that is not properly rigged may damage the boat or even endanger its passengers.

### General guidelines

**Hardware selection.** A variety of hardware is used to accommodate boat accessories. These differences are necessary due to the varying purposes of the hardware and the types of accessories that can be installed. For example, hardware may be used to fasten a component permanently or to fasten it so that quick removal is possible. The hardware may hold the component in place or allow it some freedom of movement. The two most-important considerations beyond ensuring that the hardware serves the correct purpose is to use the correct-sized hardware and to use hardware designed to survive a marine environment. For instance, a cable guide must be able to provide a secure installation so that it will remain in place despite the vibration of boat operation and the stresses exerted by the movement of the cable. It must provide an inside diameter that allows the cable to move easily, but it must also have a diameter small enough that the guide does not take up excessive space or allow the cable to kink. If the guide is susceptible to corrosion, it may become weak and brittle or deposits on its surface may restrict cable movement.

Metal hardware should be stainless steel or provide some other resistance to the high humidity and corrosive forces of the marine environment. Hoses and lines should resist deterioration in the marine environment and when exposed to the materials that they will handle. The manufacturer's packaging will indicate approval for use with fuels, high pressures, etc. Also, ensure that the materials accommodate the required capacities. The manufacturer will generally supply or specify hose diameter, wire gauges, cable strengths, and other capacity limitations. Manufacturers often include proper hardware with their installation kits. Of particular concern is that fasteners meet strength requirements, such as hardware grades.

**Secure mounting.** The technician must provide secure mounting when securing accessories to a boat. There are three aspects to this. First, there must be adequate mounting hardware. That means that the number of screws, bolts, and other securing hardware and the strength of those devices must hold the accessory in place during operation of the boat. Second, the securing hardware must be properly tightened or latched. This includes the installation of pins, locking nuts or additives, and other safeguards. Third, the technician should ensure that the installation site provides a good base for securing the accessories. This is especially true of fiberglass hulls. It may be necessary to install reinforcement such as wooden blocks or metal plates to spread the stress over a larger area to prevent crazing and cracking of the fiberglass.

**Proper installation.** Most equipment will come with installation instructions and often required hardware. The technician should ensure that the equipment is suitable for its intended use, and he or she should install the equipment in accordance with the manufacturer's directions.

### Guidelines for selecting and installing engines

- Match the engine to the boat and to the intended use of the boat.

  The engine should be of the proper horsepower, rpm rating, height, and propeller configuration for the size, weight, and intended use of the boat.

- Determine the required mounting height and whether an extension kit is required.

  Boats are generally designed so that at their top speed the antiventilation plate is even with the surface of the water.

- Determine the mounting hardware required.

  Most outboard engines are equipped with mounting brackets that clamp onto standard transoms. In some cases, the technician may have to obtain a different size of clamp to accommodate special transoms.

- Determine the impact of installation of related systems such as steering systems, tilt and trim systems, etc.

  There are a number of related systems that may be connected to the engine, and such systems may affect the installation of the engine. For example, if the engine uses a hydraulic-tilt system, a different transom mount may be required.

- Use only manufacturer-approved mounting hardware and procedures.

  Do not make unauthorized modifications to the boat or engine to accommodate your installation. Do not use hardware that does not meet the installation specifications. For example, if hardened bolts are required, do not use standard bolts.

- Ensure that the engine is properly positioned laterally along the transom.

  Normally, an engine is centered on the transom. However, in some installations, the engine may be offset to one side or the other to overcome engine torque.

### Guidelines for installing engine-control assemblies

Sitting at the rear of the boat and using the tiller arm to control the engine is not always the most convenient method of operating a boat. Many boat operators prefer that the boat be configured more like a car, allowing the operator to sit in a forward position and controlling the engine remotely. There are five primary functions that are controlled from this position: (1) starting the engine, (2) adjusting the flow of fuel to the engine (throttle control), (3) shifting the engine between forward and reverse, (4) tilting the engine, and (5) adjusting engine trim. The following covers the guidelines for installing these control assemblies.

**Remote starters.** Generally, remote starting is done with an electrical circuit similar to an automotive system. An electric motor is installed on the engine so that it engages the flywheel when the motor is running. Many engines come from the factory with the starter motor installed, often with a starter button on the tiller handle. In other cases, the technician will have to install the starter motor. If the technician must install the starter, the following considerations are most important.

- Select a starter that is specifically recommended for that engine.
- Follow the directions of the engine manufacturer and the starter-motor manufacturer for completing the installation.
- Ensure that the starter motor is securely mounted.
- Ensure that the starter motor is properly grounded. Provisions must be made to connect the starter motor electrically to the power source's ground field either through the engine ground system or through a separate connection.
- Ensure that the starter motor is not shorted. If a starter motor is grounded through its housing, it is easy to bring the housing into contact with the hot side of the circuit.
- If a second battery is used for other electrical functions, ensure that the two electrical systems are isolated from each other.

Remote control of the starter motor is generally provided by a button or a keyswitch located on the dash. Again, installation of the switch should be done in accordance with the manufacturer's instructions. Generally, the boat owner will be able to choose the type of switch to be installed and its location. The owner's preferences should be honored unless there is some safety or operational conflict.

Many starter switches are mounted to or through the dash panel. The technician should strive to make the installation attractive. Often the installation will require drilling one or more holes in the dash panel. The installation instructions may include a template to assist with the locating of those holes along with recommended drill-bit sizes.

The wiring for the system must be the correct gauge. The wiring should be routed in such a way that it does not present a tripping hazard or interfere with the operation of other systems while also avoiding the potential for shorting.

## Student Supplement 2

Some starter-system switches will include safety lanyards. The technician must ensure that lanyard operation is functional. For example, the starter switch cannot be located in a position that is outside the comfortable range of the lanyard or placed where the lanyard cord will interfere with the operation of other systems, such as the steering system.

**Throttle control.** Most throttle controls are lever-operated devices mounted to the right of the boat operator. They generally use cables routed to a control rod or lever on the engine and operate like throttle levers on lawn mowers. The primary concerns in proper installation are that the cable is the correct length for the installation and that it will operate without binding. Most throttle-control-system cables will consist of a metal sheath with a stiff wire that moves within the sheath. The required length is one in which the cable can be routed out of the way with a minimum length and number of bends. Where bends are necessary, they will have a minimum radius as recommended by the manufacturer. Cable-bend radius refers to how sharply the cable is bent. If a cable bend is thought of as a portion of a circle, bend radius is the distance from the cable to the center of that circle. The greater the length of the radius, the less likely it is that the wire will bind inside the sheath.

Another factor in throttle-control selection is that the travel distance of the control lever is adequate to cause the carburetor throttle to travel over its full range. Otherwise, the engine will not be able to reach its full rpm or will not idle down to its lowest speed.

Throttle-control assemblies may be integrated with other controls such as choke controls or even tilt and trim controls. The technician must ensure that the installation of an integrated control assembly allows the proper operation of each function.

**Tilt, trim, and shift.** Available as separate or integrated control assemblies, these systems allow remote operation of their related functions. All three are available with mechanical or electrical linkages. Additionally, the tilt and trim functions may use hydraulic actuation. Consequently, the technician must ensure that the interfaces between these power-transfer linkages operate properly.

Concerns for mechanical and electrical installations are the same as those described above for starting and throttle systems. For hydraulic control of tilt and trim, the hydraulic components are generally built into the engine design, and the technician is basically responsible for ensuring that those components can be correctly controlled by the linkage from the control assembly.

### Guidelines for selecting and installing steering systems

A common task for outboard-engine technicians is the installation of a steering system in medium-sized boats as an upgrade of the boat's capabilities. Additionally, technicians are called upon to service existing systems, which may include the replacement of parts. These procedures normally involve cable systems, and the guidelines provided here address such systems. Hydraulic-system installation and maintenance must be done in strict adherence to the system manufacturer's instructions. The guidelines on the next page apply to throttle and shift cables as well.

## Student Supplement 2

- Match the steering system to the boat.

  The suitability of a steering system depends on a number of factors, including the hull design and size, the size of the engine, the number of engines, the way the boat is operated, whether power assist is going to be used, etc. The goal is to provide a steering system that is physically capable of providing effective, responsive steering across the full range of speeds and maneuvers that the boat will be expected to achieve in a way that allows the operator to control the boat safely, confidently, and comfortably.

- Match the steering system to the operator's preferences.

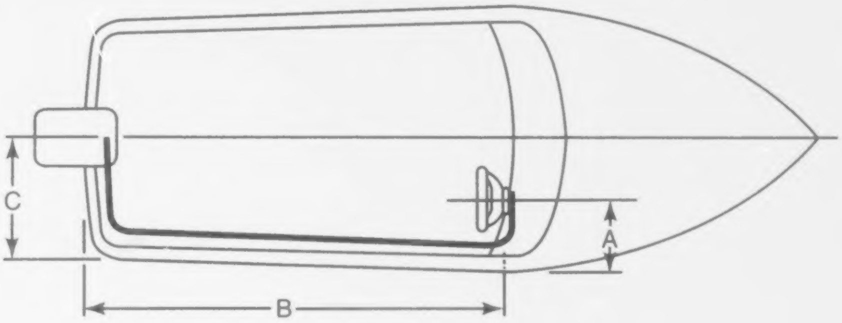
  Is the boat to be steered while the operator is standing or seated? How tight a steering system does the operator want? Does the operator prefer the steering wheel to be vertical or at an angle? The answers to these and other questions affect the installation. For example, the tightness of a steering system relates to how many turns of the steering wheel it takes to turn the engine from a full-left to a full-right position or vice versa. A typical system may require 2.5, 3, or 3.5 turns for a full range of engine swivel. A greater number of turns means less effort is required but more turns are needed to achieve the same engine pivot. The positioning of the steering wheel must also be considered. Typical marine systems are designed so that the wheel is parallel to the dash or tilted at an angle of approximately 20 degrees to the dash.

- Plan the cable routing to be as direct as possible (see Figure 1 on the next page).

  Force is lost over the distance of the cable. The longer the cable, the greater the loss of force. Further, cable with excessive slack is more likely to have backlash. Finally, the extra cable is a waste of space, money, and installation time.

## Student Supplement 2

**Figure 1:** How to measure for new steering-cable installations



A = Distance from the center line of the wheel to the gunwale.
+B = Distance from the dash to the transom.
+C = Distance from the gunwale to the center line of the transom or engine tilt tube.
Total = Basic measurement

The total of A+B+C is your basic measurement. From that total, deduct 4 inches for every 90-degree bend in the cable. For installations that are mounted to the transom or splashwell, deduct 6 inches. For installations through the engine tilt tube, add 6 inches. Then, round the final total up to the next whole foot.

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- Keep the number of bends to a minimum.

  Each bend reduces the efficiency of force transmission and introduces an opportunity for backlash. The total bends in a cable should never exceed 360 degrees. For example, in a typical installation where the cable runs from the steering column to the side of the hull, along the hull to the transom, and along the transom to the engine, two 90-degree turns are required, for a total of 180 degrees. If the technician were to run the cable to the floor of the hull, to the side, to the transom, and up to the engine, two more 90-degree bends would be introduced. This brings the number of bends to four and the total amount of turns to 360 degrees; further, this approach uses considerably more cable.

- Allow the largest bend radii practical.

  The angle of the bend is not the only consideration in changing the direction of cable routing. How sharply the turn is made also affects the installation and efficiency of the cable. This aspect of cable routing is referred to as *bend radius.* The term applies to a hypothetical circle that could be drawn using the curve of the cable turn as a segment of the circle. The radius is the distance between the cable and the center of that circle. The longer the radius, the more gradual is the curve of the bend. A longer bend radius improves the force-transmission efficiency of the bend. However, long radii take up more space, so a practical compromise must be achieved in each case.

- Use a cable of the proper length.

  A technician may choose to order extra length in a cable to allow for mistakes in measuring or other problems. However, every extra inch of cable decreases the efficiency of the cable, while a cable that is too short may reach the engine but not allow full movement in pivoting or may stress the system components. A typical method recommended by cable manufacturers is to measure the distance of the routing, deduct an amount for each bend, adjust the length for the method of connecting the cable to the engine, and then round that distance up to the next whole foot to determine the total cable length.

- Use only approved cable.

  Steering cable is specifically designed for use in marine applications. The output ends are anticorrosive stainless steel, while the outer jacket is a special plastic compound that resists deterioration from the sun, rain, and other elements.

- Straighten the cable prior to installation.

  The new cable should be removed from its carton and unwound onto a clean, dry, level surface. The technician should then gently shake the cable to remove any remaining kinks and check the cable by hand, feeling for kinks along the length of the cable. Cable that is excessively kinked or damaged should not be installed.

- Use care not to step on the cable or subject it to unnecessary bending and stresses.

  Excessive pressure can permanently deform a cable or damage the jacket so that the cable does not move easily inside the jacket. The technician must be careful not to step on the cable, drop heavy objects on it, place it in a bind, drag it over sharp surfaces, or otherwise damage it.

- Use ties or hangers to secure the cable every 6 feet (2 meters).

  If the cable is not secured along its length, the friction between the cable and its jacket tends to make the cable assembly bend rather than move the free end. Additionally, unsecured cable can become damaged or present hazards to boat passengers.

- Lubricate the cable and installation as recommended.

  Internal lubrication of the cable is not required. However, the cable or steering-system manufacturer may recommend lubricating the steering gear or other components.

## Student Supplement 2

### Guidelines for selecting and installing tank-to-engine line

External fuel tanks for outboard engines are classed as (1) permanent or (2) portable. A permanent tank is attached to the hull, while a portable tank is connected to the engine temporarily and can be removed without much effort. A typical portable system is illustrated in Figure 2 on the next page with components labeled.

- Hose, lines, and connectors should be certified for use with fuel.

  Not all lines and hoses are rated for carrying fuel. Those lines and hoses that are approved for fuels will be labeled to indicate the types of fuels for which they can be used. This labeling is usually placed on the packaging and often on the hose itself.

- The tank must be located so that it will be adequately ventilated.

  Ventilation may be natural-draft ventilation or forced-air ventilation and should be adequate to ensure that fumes do not accumulate.

- If a quick-disconnect line is installed, it must provide an automatic-shutoff capability.

  Avoid spilling fuel when working with fuel systems. The connections that are routinely removed should have a means of shutting off fuel (automatic-shutoff capability) to reduce the amount of fuel that the lines contain.

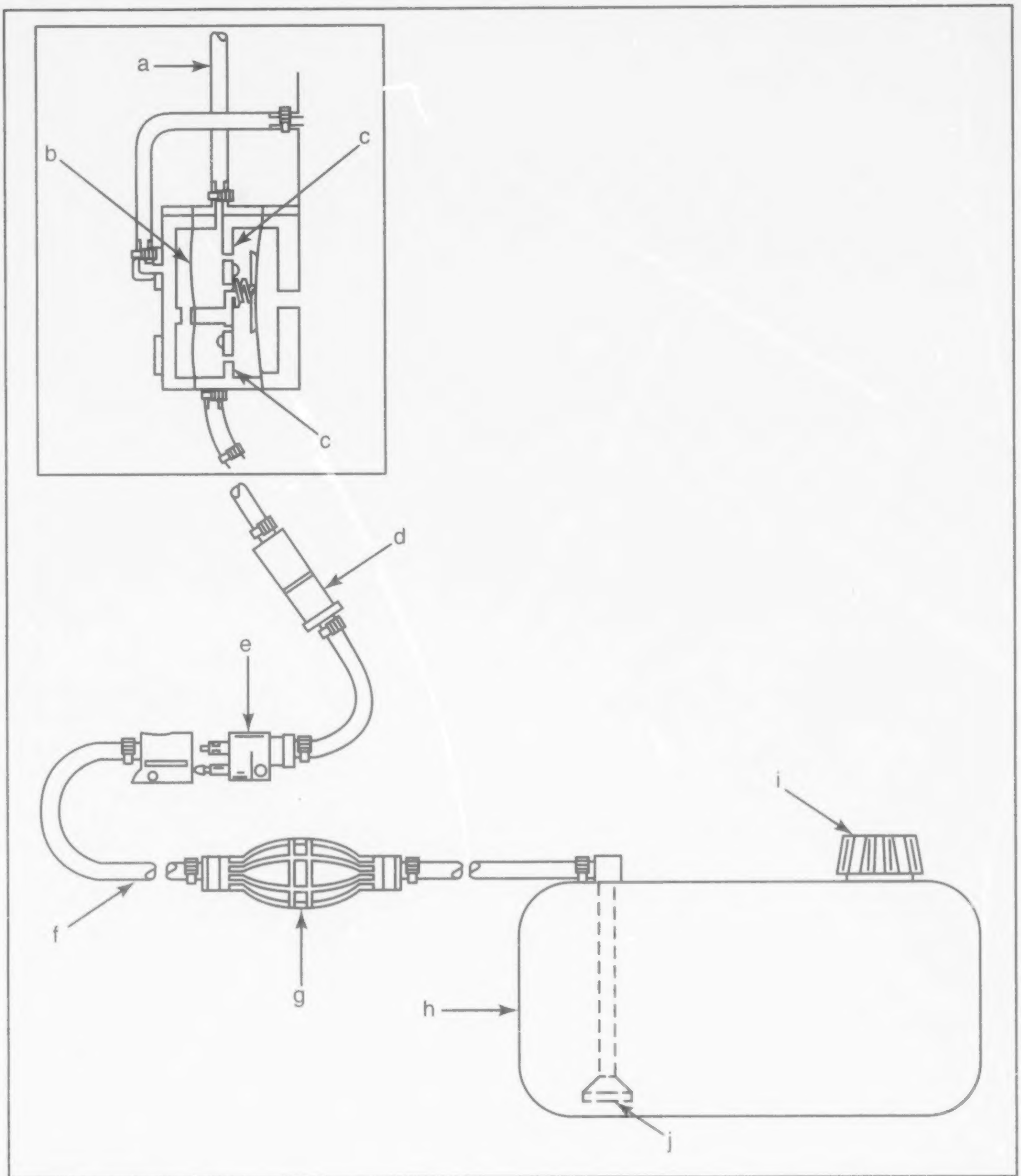
- The hose diameter and length must comply with installation requirements.

  Many fuel systems will specify a hose diameter based on the distance between the tank and fuel pump.

- If an anti-siphon valve is installed, it must have adequate capacity to match the engine horsepower.

## Student Supplement 2

**Figure 2:** Portable external fuel tank



a - Fuel-pump outlet to carburetor
b - Diaphragm
c - Check valve
d - Fuel filter
e - Fuel connector
f - Fuel line
g - Primer bulb
h - Fuel tank
i - Fill cap
j - Fuel pick-up

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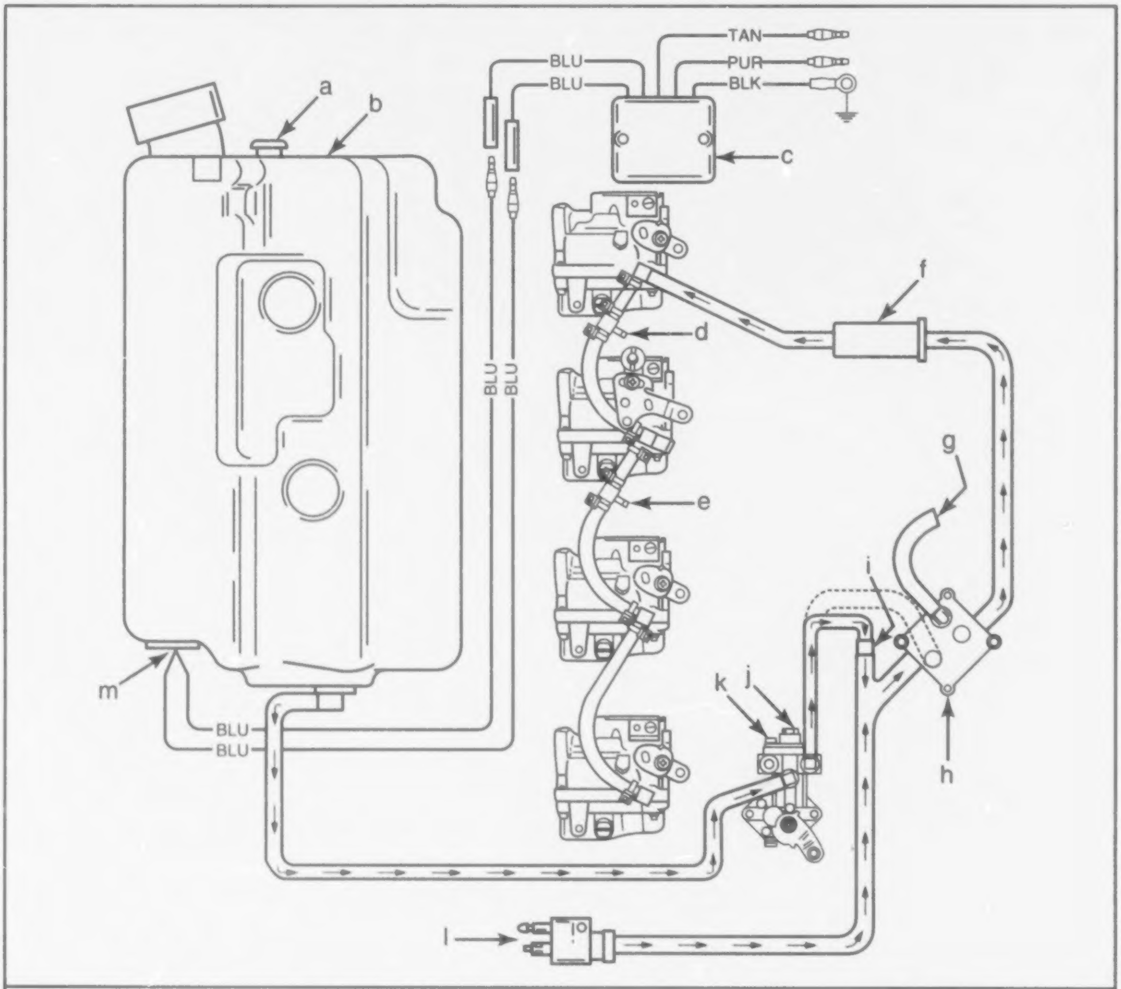
### Guidelines for installing remote oil tanks

There are two types of remote-oil-tank installations: (1) those that use separate oil and fuel pumps, as in Figure 3, and (2) those that use a single pump for both fuel and oil. Other components in the system include connecting lines and pressure warning systems. Figure 3 below shows a four-cylinder system. Note that separate oil and fuel pumps are used.

- Install a check valve at the connection of the fuel system to prevent fuel from entering the oil lines.
- Ensure that the line diameter is that recommended by the manufacturer to allow sufficient oil flow to provide the proper oil/fuel ratio.

**Figure 3:** Four-cylinder system



a - Oil-tank vent
b - Oil tank
c - Low-oil/overheat-warning module
d - Fuel-enrichment-valve fuel fitting
e - Accelerator-pump fitting (4-cylinder models only)
f - Fuel filter
g - To crankcase pulse fitting
h - Fuel pump
i - 2-psi check valve
j - Oil-pump bleed valve
k - Oil pump
l - Fuel-inlet fitting
m - Low-oil sensor

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## Student Supplement 2

### Guidelines for installing batteries

Batteries are used on boats to power electric starter motors and other electrical accessories. Often, a boat with a number of electrical accessories will have more than one battery system. These systems frequently share the same charging system but are otherwise electrically isolated from each other.

The following guidelines apply to the handling and installation of batteries.

- Be sure that the selected battery is rated for marine use. Marine batteries are generally labeled as such by the manufacturer and are specifically designed for operation in the corrosive atmosphere of the marine environment.

  Note: Many marine batteries are not rated in the same way as automotive batteries. For example, the cold-cranking amperage of marine batteries is based on a temperature of 0°F while automotive batteries are rated at 32°F.

- Ensure that the battery is rated to handle the systems that will be powered by it. The battery should have adequate amperage and voltage to power the intended systems and be capable of recharging at a fast enough rate to maintain adequate storage capacity. This may require that the technician examine the power requirements of the systems to be powered and compare those to the battery capacities defined by the battery manufacturer.
- Ensure that electrical circuits are adequately protected with fuses or circuit breakers, including proper grounding through the battery circuit.
- Wear eye protection and protective clothing, including rubber gloves and apron, when servicing batteries.
- Ensure that the installation site is protected so that people and objects are not likely to come into contact with the battery terminals, which can cause arcing.
- Ensure that the battery is secure so that it will not tip over and spill electrolyte.
- Ensure that the installation site is vented. Recharging batteries can give off explosive fumes. The installation site must be vented so that those fumes do not get trapped inside the battery compartment.
- Do not smoke around batteries, especially when they are charging.
- Wash your hands thoroughly after handling batteries.
- Dispose of discarded batteries properly.

### Guidelines for installing pitot systems and transducers

Land-based systems have drive wheels that allow the speed of the vehicle to be measured based on the rate the wheels are turning. However, boats do not have that ability. While it is possible to measure engine rpm with a tachometer, engine speed is not a reliable indication of how fast a boat is traveling because water current, wind, and loads (such as a number of passengers or skiers) can affect the number of rpm's required to maintain a desired engine speed. Thus, another method is required to measure boat speeds. Many boats use a *pitot* (pronounced *pee-toh*) system; these devices use a tube with a small opening in it that allows water to pass through it. The moving water possesses mechanical energy that can then be used to power mechanical devices or converted to another form of energy to power other types of devices. A common configuration is to convert the mechanical energy of the pitot system into electrical energy with a device called a *transducer.* This electrical energy is then available to power devices such as speedometers that provide the boat operator with an indication of the speed at which the boat is traveling.

It is beyond the scope of this course to discuss the many designs of pitot systems and transducers. However, all such systems have some common installation principles, as outlined below.

- Follow the manufacturer's instructions for installation.
- Ensure that pitot tubes are positioned so that they will capture water flow, as prescribed by the manufacturer.
- Ensure that the pitot tube is not likely to be damaged or obstructed at the installation site.
- Use care when handling pitot tubes as they are fragile and cannot be repaired if damaged.
- Ensure that the components of the system—pitot, transducer, and instruments—are suited to the application. For example, the system must track speeds over the operating range of the boat. It will do no good to install a system that has a range of 0 to 40 knots if the boat is to be operated at 80 knots.
- Ensure that the pitot and transducer are suited to each other and to the type of display to be used. For example, some transducers are suited for digital displays, while others are not. Follow the speedometer manufacturer's recommendations for a data-input system.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Assignment Sheet 1—Determine Specifications for Selecting and Installing Outboard Engines

Name ______________________ Date ______________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________

______________________

______________________

**Introduction** An engine must be properly matched to the boat and its intended use. This includes selecting the proper horsepower of engine and related features with regard to whether the engine will use electric starting, remote steering and control, etc. The engine must be installed at the proper height. Outboard engines have standard heights, so basically the selection of the engine includes identifying the height that will allow the propeller to extend the proper distance into the water. The engine must also be equipped with a propeller appropriate to the boat's intended use. This assignment sheet will provide you with practice in matching engines to specific boats and their intended uses.

**Exercise**

**Directions** Read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems." Next, have your instructor complete the first three items in each section of this assignment sheet. Then, using the resources available in your facility, determine the answers to questions 1 through 7 in each "Technician-provided information" section. Write your answers on the blanks provided with each question.

## Assignment Sheet 1

**Part A** **Boat system 1**

Instructor-provided information

1. Make and model of boat —
2. Length of boat —
3. Intended use of boat —

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model —

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height —

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware —

6. How will the engine be positioned on the transom?

   Engine position —

7. What propeller should be used with this engine and boat application?

   Propeller —

## Assignment Sheet 1

### Part B — Boat system 2

**Instructor-provided information**

1. Make and model of boat — ____________________

   ____________________

2. Length of boat — ____________________

   ____________________

3. Intended use of boat — ____________________

   ____________________

   ____________________

**Technician-provided information**

1. What engine would you select for this boat and its intended use?

   Engine make and model — ____________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ____________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ____________________

   ____________________

   ____________________

6. How will the engine be positioned on the transom?

   Engine position — ____________________

   ____________________

   ____________________

7. What propeller should be used with this engine and boat application?

   Propeller — ____________________

## Assignment Sheet 1

**Part C** **Boat system 3**

Instructor-provided information

1. Make and model of boat — ______________________________

______________________________

2. Length of boat — ______________________________

______________________________

3. Intended use of boat — ______________________________

______________________________

______________________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model — ______________________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ______________________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ______________________________

   ______________________________

   ______________________________

6. How will the engine be positioned on the transom?

   Engine position — ______________________________

   ______________________________

   ______________________________

7. What propeller should be used with this engine and boat application?

   Propeller — ______________________________

## Assignment Sheet 1

**Part D** **Boat system 4**

Instructor-provided information

1. Make and model of boat — ______________________________

______________________________

2. Length of boat — ______________________________

______________________________

3. Intended use of boat — ______________________________

______________________________

______________________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model — ______________________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ______________________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ______________________________

   ______________________________

   ______________________________

6. How will the engine be positioned on the transom?

   Engine position — ______________________________

   ______________________________

   ______________________________

7. What propeller should be used with this engine and boat application?

   Propeller — ______________________________

## Assignment Sheet 1

**Part E** **Boat system 5**

Instructor-provided information

1. Make and model of boat — ______________________

______________________

2. Length of boat — ______________________

______________________

3. Intended use of boat — ______________________

______________________

______________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

Engine make and model — ______________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

Yes No

3. What is the correct mounting height for the engine selected?

Mounting height — ______________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

Yes No

5. What mounting hardware will be required for the engine installation?

Mounting hardware — ______________________

______________________

______________________

6. How will the engine be positioned on the transom?

Engine position — ______________________

______________________

______________________

7. What propeller should be used with this engine and boat application?

Propeller — ______________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Assignment Sheet 2—Determine Specifications and Parts Requirements for Rigging and Accessories for Outboard-Engine Boat Systems

Name ____________________ Date ____________

---

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

____________________________________________

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**Introduction** Accessories do a lot to define the operation of a boat and to please those who use it. They continue to grow in popularity and provide numerous opportunities for technicians in terms of installation and service. Lots of boaters want to have all the latest gadgets. This means that technicians have to be able to install and adjust such accessories, but a good technician is also able to evaluate other requirements. For example, is a larger battery required, should circuit breakers or fuses be installed, what is the impact on the charging system, etc.? This assignment sheet will provide you with practice in evaluating requirements for installation of rigging and accessories.

**Exercise**

**Directions** Read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems," and Scenario 1 and Scenario 2 on the following pages. Then, using the resources available in your facility, determine the part numbers and specifications requested. Write your answers on the blanks provided with each scenario.

## Assignment Sheet 2

**Part A** **Scenario 1**

A customer wants to equip a 14-foot runabout with a steering system and remote control for the throttle and tilt and trim functions. Working with the materials in your facility, select appropriate equipment to support these functions, and describe how the equipment will be installed.

## Assignment Sheet 2

**Part B** **Scenario 2**

A boat owner wants a digital speedometer installed on her 16-foot ski boat. The boat does not have a pitot system. What equipment would you choose for this? List the equipment to support these functions, and describe how the equipment will be installed.

# Orientation to Outboard-Engine Boat Systems and Rigging
# Unit 1

## Assignment Sheet 3—Inspect Outboard-Engine Boat Systems and Rigging

Name ______________________ Date ______________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________________

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______________________________________

**Introduction**

This assignment sheet covers the inspection of outboard-engine boat systems. This is not a detailed inspection of the engine and system specifications but a general assessment of the safety, physical condition, and security of the boat-system components. The inspection includes the condition of the boat hull, support systems, and engine installation. The exact steps for the inspection will depend on the boat material and hull design, types of engine and support systems, and the conditions of these components. Some general aspects of the inspection include

- Cracks, deformities, corrosion, rust, rot, and other defects in the hull.
- Wear, alignment, deformities, corrosion, cable fraying, and other defects in moving parts.
- Secure fastening of the engine, hardware, windshield, top, seats, fuel tank, and other attached components.
- General condition of the overall system.

**Exercise**

**Directions**

First, read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems." Next, have your instructor provide you with two outboard-engine boat systems. Then, inspect these boat systems and record your findings by completing the inspection checklists on the following pages.

## Assignment Sheet 3

**Part A** **Boat system 1 inspection checklist**

1. Type of boat hull (displacement or planing) — ____________________

2. Hull material used (fiberglass, wood, plywood, aluminum, etc.) —

3. Hull shape (flat, vee, catamaran, etc.) — ____________________

4. Type of engine (make and model) — ____________________

5. Application (intended use of boat system—workboat, runabout, sport boat, etc.) — ____________________

6. Describe the overall condition of the hull. (Any fouling, rot, crazing, etc.?)

7. Describe the overall condition of the rigging. (Any wear, alignment, deformities, corrosion, cable fraying, defects in moving parts?)

8. Describe the fastening of the engine, hardware, windshield, top, seats, fuel tank, and other attached components.

## Assignment Sheet 3

9. Describe the general condition of the overall boat system.

10. Identify and describe any boat-system repairs and any other recommendations you would suggest to the boat's owner.

## Assignment Sheet 3

**Part B** **Boat system 2 inspection checklist**

1. Type of boat hull (displacement or planing) — ____________________

2. Hull material used (fiberglass, wood, plywood, aluminum, etc.) — ____________________

3. Hull shape (flat, vee, catamaran, etc.) — ____________________

4. Type of engine (make and model) — ____________________

5. Application (intended use of boat system—workboat, runabout, sport boat, etc.) — ____________________

6. Describe the overall condition of the hull. (Any fouling, rot, crazing, etc.?)

7. Describe the overall condition of the rigging. (Any wear, alignment, deformities, corrosion, cable fraying, defects in moving parts?)

8. Describe the fastening of the engine, hardware, windshield, top, seats, fuel tank, and other attached components.

## Assignment Sheet 3

9. Describe the general condition of the overall boat system.

10. Identify and describe any boat-system repairs and any other recommendations you would suggest to the boat's owner.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 1—Install and Adjust Outboard Engines

**Introduction**

This job sheet covers the installation and adjustment of outboard engines. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Assemble engine system
- Install engine
- Adjust engine height
- Adjust trim tab
- Adjust controls
- Connect instruments, such as tachometers, temperature gauges, fuel gauges, etc.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting outboard engines and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a boat and an outboard engine to install.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 1

## Worksheet—Install and Adjust Outboard Engines

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 1

## Worksheet—Install and Adjust Outboard Engines

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | |
| Procedures completed correctly. | |
| Proper tools used correctly. | |
| Safety precautions observed. | |
| Service meets specifications. | |
| Clean-up and follow-up actions adequate. | |
| **Overall rating** | |

**Evaluator's comments** ______________________________

______________________________

______________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 2—Install and Adjust Remote Engine-Control Assemblies

**Introduction**

This job sheet covers the procedure for installing and adjusting remote engine-control assemblies. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions and other reference materials. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Connect control assembly to engine
- Install control box and cabling
- Adjust linkages

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.
2. Watch your instructor's demonstration of installing and adjusting remote engine-control assemblies and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one control assembly. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a remote engine-control assembly.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 2

## Worksheet—Install and Adjust Remote Engine-Control Assemblies

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 2

## Worksheet—Install and Adjust Remote Engine-Control Assemblies

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 3—Install and Adjust Steering Systems

**Introduction**

This job sheet covers the procedure to install and adjust steering systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Install steering-input device, such as a steering wheel
- Plan cable routing and install cables
- Connect steering linkages between input device and engine pivot connection, including hydraulic actuators if used
- Adjust steering linkages
- Lubricate gears, linkages, and other moving parts
- Adjust fluid levels for hydraulic systems

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting steering systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one steering system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a boat that requires installation of a steering system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/ materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 3

## Worksheet—Install and Adjust Steering Systems

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 3

## Worksheet—Install and Adjust Steering Systems

**Part B:** **Performance evaluation**

**Evaluation criteria** **Rating**

Correct procedures identified for assigned equipment. ________

Procedures completed correctly. ________

Proper tools used correctly. ________

Safety precautions observed. ________

Service meets specifications. ________

Clean-up and follow-up actions adequate. ________

**Overall rating** ________

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 4—Install Tank-to-Engine Fuel Lines

**Introduction**

This job sheet covers the procedures for installing tank-to-engine fuel lines. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Measure and size line lengths
- Route and secure lines
- Connect lines to fuel tank
- Connect lines to engine
- Install filters

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing tank-to-engine fuel lines and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one fuel system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of tank-to-engine fuel lines.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/ materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 4

## Worksheet—Install Tank-to-Engine Fuel Lines

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A:** **Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 4

## Worksheet—Install Tank-to-Engine Fuel Lines

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 5—Install Remote Oil Tanks

**Introduction**

This job sheet covers the procedure for installing remote oil tanks. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Secure tank
- Connect lines to engine and tank
- Verify oil flow

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.
2. Watch your instructor's demonstration of installing remote oil tanks and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a remote oil tank.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/ materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 5

### Worksheet—Install Remote Oil Tanks

Name ____________________ Attempt number __________

Date ____________________

---

**Part A: Pre-performance check**

Job ____________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ____________________

  Equipment model/type and code ____________________

  ____________________

- Complete the following service-manual information.

  Service-manual title ____________________

  Section/page number of procedure ____________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ____________________

## Job Sheet 5

## Worksheet—Install Remote Oil Tanks

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________________

________________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 6—Service and Install Batteries

**Introduction**

This job sheet covers the procedures for servicing and installing batteries. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Select appropriate battery for application
- Test and charge battery as required
- Adjust battery fluid level
- Install battery
- Connect electrical circuits to battery

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of servicing and installing batteries and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires the installation of a battery.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 6

## Worksheet—Service and Install Batteries

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 6

## Worksheet—Service and Install Batteries

---

**Part B:** **Performance evaluation**

| Evaluation criteria | Rating |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 7—Install and Adjust Pitot Systems

**Introduction** This job sheet covers the procedures for installing and adjusting pitot systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Create installation area for pitot tube and system
- Attach pitot tube
- Install transducer and electrical circuits
- Connect pitot system and gauges
- Adjust pitot system

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting pitot systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a pitot system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 7

## Worksheet—Install and Adjust Pitot Systems

Name ______________________ Attempt number ________

Date ______________________

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 7

## Worksheet—Install and Adjust Pitot Systems

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

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# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 8—Install and Adjust Transducer Systems

**Introduction** This job sheet covers the procedure for installing and adjusting transducer systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Install sensors, transducers, and instruments
- Install wiring
- Adjust transducer system

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting transducer systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one transducer system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires the installation of a transducer system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 8

## Worksheet—Install and Adjust Transducer Systems

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 8

## Worksheet—Install and Adjust Transducer Systems

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | _______ |
| Procedures completed correctly. | _______ |
| Proper tools used correctly. | _______ |
| Safety precautions observed. | _______ |
| Service meets specifications. | _______ |
| Clean-up and follow-up actions adequate. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** ________________________________________

__________________________________________________________

__________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 9—Install and Adjust Instruments and Gauges

**Introduction**

This job sheet covers the procedures for installing and adjusting instruments and gauges. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Select instruments and gauges
- Prepare boat for installation
- Install instruments and gauges
- Make electrical connections
- Adjust instruments and gauges

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.
2. Watch your instructor's demonstration of installing and adjusting instruments and gauges and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one type of instrument. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system and instruments for installation.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/ materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 9

## Worksheet—Install and Adjust Instruments and Gauges

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 9

## Worksheet—Install and Adjust Instruments and Gauges

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging

# Unit 1

## Job Sheet 10—Install and Adjust Electrical Accessories

**Introduction**

This job sheet covers the procedures for installing and adjusting electrical accessories. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Prepare boat for installations
- Install electrical accessories
- Install wiring
- Install circuit breakers and fuses
- Install controls
- Make electrical connections
- Adjust electrical accessories

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting electrical accessories and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one type of electrical accessory. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of an electrical accessory.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 10

## Worksheet—Install and Adjust Electrical Accessories

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 10

## Worksheet—Install and Adjust Electrical Accessories

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

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## Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 11—Install and Adjust Hardware Accessories

**Introduction** This job sheet covers the procedures for installing and adjusting hardware accessories. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Prepare boat for installation
- Install accessories
- Interconnect accessories to other systems
- Adjust hardware accessories and other systems

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting hardware accessories and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one hardware accessory. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a hardware accessory.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 11

## Worksheet—Install and Adjust Hardware Accessories

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 11

## Worksheet—Install and Adjust Hardware Accessories

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Objective Sheet

### Unit objective

After completing this unit, the student should be able to identify the major components of trailers used for outboard-engine boat systems; select, maintain, and repair trailers; safely tow trailers and outboard-engine boats; and safely launch, operate, and load outboard-engine boats. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific objectives

After completing this unit, the student should be able to

1. Match the major components of trailers used with outboard-engine boat systems to their correct functions.
2. List the design characteristics used to classify trailers.
3. State guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle.
4. Describe the purposes of the trailer bow-stop and tongue-weight adjustments.
5. List types of trailer brake systems.
6. Complete statements about the principles of hydraulic-brake-system operation.
7. Complete statements about the principles of electric-brake-system operation.
8. Complete statements about the principles of surge-brake-system operation.
9. List the typical service procedures required for trailers.
10. Determine trailer specifications and parts requirements. (Assignment Sheet 1)
11. Select trailers for outboard-engine boat systems. (Assignment Sheet 2)
12. Inspect trailers. (Assignment Sheet 3)
13. Complete a boat-safety exam. (Assignment Sheet 4)
14. Perform routine maintenance on trailers. (Job Sheet 1)
15. Repair trailers. (Job Sheet 2)
16. Safely tow outboard-engine boats. (Job Sheet 3)
17. Safely launch outboard-engine boats. (Job Sheet 4)

## Objective Sheet

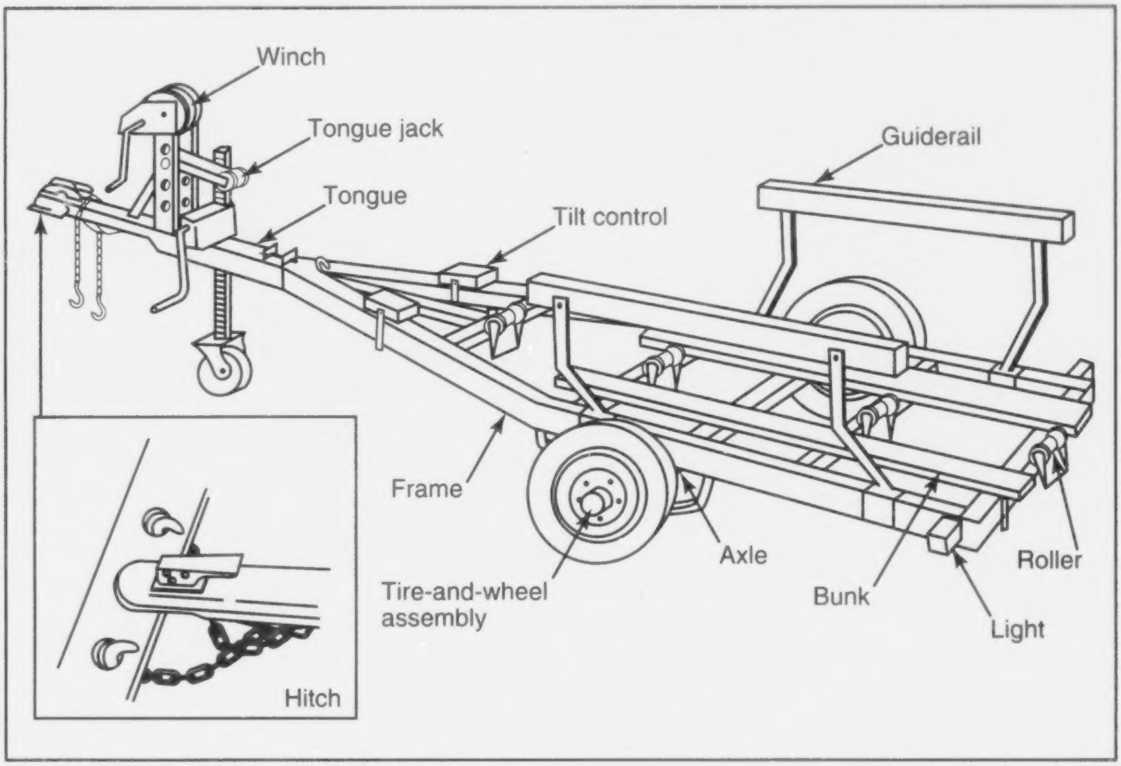
18. Safely operate outboard-engine boats. (Job Sheet 5)
19. Safely load outboard-engine boats. (Job Sheet 6)

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Information Sheet

1. **Major components of trailers used with outboard-engine boat systems and their functions** (see Figure 1)

**Figure 1:** Major components of trailers


Winch
Tongue jack
Tongue
Guiderail
Tilt control
Frame
Tire-and-wheel assembly
Axle
Bunk
Roller
Light
Hitch

- **Hitch**—Fastens the trailer to the tow vehicle
- **Tongue**—Provides an extension from the trailer to the tow vehicle to allow adequate clearance between the tow vehicle and the boat during turns
- **Tongue jack**—Raises and lowers the tongue to position the hitch to the tow-vehicle bumper and to level the trailer during storage
- **Winch**—Provides a mechanism for loading a boat onto its trailer and for lowering the boat from the trailer
- **Frame**—Forms the support framework for the other trailer components

## Information Sheet

- **Boat supports** (bunks, rollers, and guiderails)—Form the support framework for the boat

  Note: Three types of boat supports are used on many trailers—bunks, rollers, and guiderails. Bunks are carpet-covered planks that support the boat hull. Bunks are normally attached to the trailer frame so that they pivot as the position of the boat shifts. Rollers support the boat keel and roll to assist in loading and unloading the boat on the trailer. Some trailers will not have bunks; some will only have rollers; some will have both bunks and rollers. Some trailers also have guiderails to support the sides of the boat.

- **Axle**—Supports the frame and secures the tire-and-wheel assemblies to the trailer

  Note: A trailer may have one, two, three, or more axles. Typically, the frame is mounted to the axle assembly by a suspension system that includes springs and, often, shock absorbers.

- **Tire-and-wheel assembly**—Houses the wheels, wheel bearings, and the brakes

  Note: The parts of the tire-and-wheel assemblies must be serviced regularly for the safe and dependable operation of the trailer. This is especially important because the wheels are frequently submerged while the boat is being loaded and unloaded.

- **Tilt control**—Allows a portion of the boat support to be raised mechanically, electrically, or hydraulically

- **Light system**—Illuminates the trailer to improve its visibility and to provide information to other drivers

  Note: Light systems for trailers usually consist of taillights and brake lights as a minimum, but many trailers may also have other lights such as running lights or license-plate lights.

### 2. Design characteristics used to classify trailers

Note: While trailers vary in some details such as number of axles, type of hitch, etc., four characteristics are normally used to classify trailer designs: (1) type of boat support used, (2) degree of submersibility, (3) use of tilt control, and (4) load capacity.

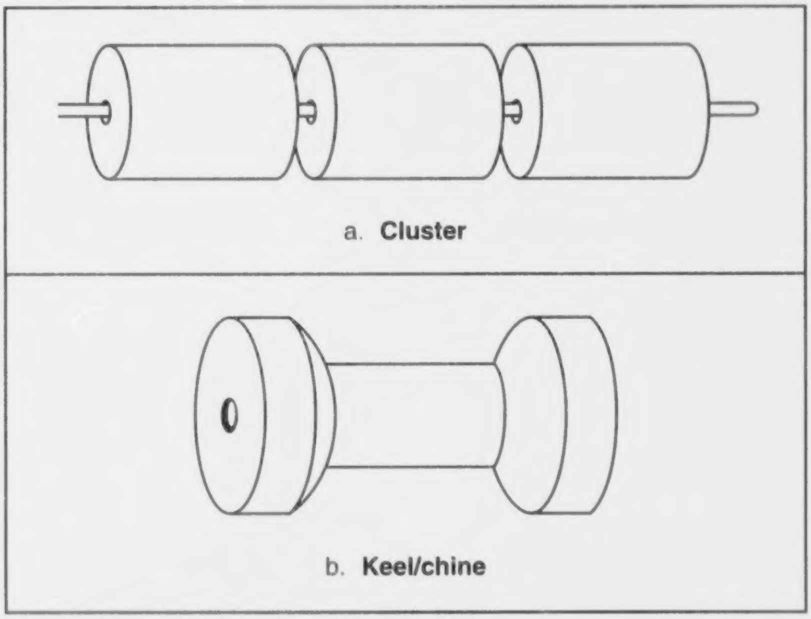
- **Type of boat support used—rollers or bunks** (see Figure 1 on the previous page)

  Note: The two principal purposes of trailers are (1) to transport boats or (2) to store boats. One basis, then, for selecting a trailer for a particular boat is to decide which will be the primary purpose for the trailer. For example, if a boat will be loaded and unloaded frequently, then a roller design may be desirable; if a boat will be stored for long periods of time, a bunk design may be preferable.

  The two most-common configurations of rollers are cluster and keel/chine (see Figure 2 on the next page). The cluster configuration has rollers scattered over the support area while the keel/chine design provides support for specific hull areas. Roller supports are intended for use with the weight of the boat being supported by the trailer rather than by water. Bunks are normally used for boats under 20 feet in length, and bunk supports are often used with rollers for the keel. Both rollers and bunks can be adjusted to better fit the hull shape of a boat.

## Information Sheet

**Figure 2:** Cluster and keel/chine roller configurations


a. **Cluster**

b. **Keel/chine**

- **Degree of submersibility—submersible or fully submersible**

  Note: All quality boat trailers can tolerate exposure to water, but some can tolerate more exposure than others. Fully submersible trailers are designed so that they can be backed well into the water to launch the boat, and the trailer's electrical system, wheel bearings, metal parts, and other components are specifically protected against damage by water.

- **Use of tilt control**

  Note: Some trailers allow a portion of the boat support to be raised mechanically, electrically, or hydraulically.

- **Load capacity**

  Note: The frame and the suspension system of a trailer are designed to withstand a certain amount of weight safely. By U.S. Coast Guard regulations, each trailer carries a label showing its load capacity.

3. **Guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle**

- The trailer must be able to accommodate the weight of the boat.

- The trailer must be able to accommodate the shape and dimensions (length and width) of the boat.

  Example: The length of the trailer must allow the boat to be loaded without excessive overhang.

- The hitch system of the trailer must be compatible with the hitch system on the tow vehicle.

## Information Sheet

### 4. Purposes of the trailer bow-stop and tongue-weight adjustments

Note: Most trailers allow adjustments of the bow stop and tongue weight to accommodate the dimensions and weight distribution of the boat that will be towed.

- **Bow-stop adjustment**—The bow stop provides the forward rest for the boat. The bow stop must be set at the proper height to correctly distribute the balance of the load as the boat is thrust forward on the trailer by the momentum of towing.
- **Tongue-weight adjustment**—The weight of the boat and trailer must be properly balanced at the hitch system between the tow vehicle and the trailer. Excessive weight on the bumper can damage the tow vehicle or cause separation between the tow vehicle and the trailer. Excessive weight on the trailer can cause the trailer to track erratically. The tongue can be lengthened or shortened to change the balance point of the trailer, which changes the amount of weight that rests directly on the bumper of the tow vehicle.

### 5. Types of trailer brake systems

Note: Braking is initiated in the tow vehicle. For many tow vehicles, the weight of the boat and trailer would be too much additional weight for the vehicle's brake system to handle. Consequently, a trailer has its own brake system that works in conjunction with the tow vehicle's brake system.

Because the tow vehicle and the trailer are separate systems, there must be a means of transmitting power from the tow vehicle to the trailer so that the brakes on both can work together. The principal ways of transmitting power to the trailer's brake system are (1) hydraulics, (2) electricity, and (3) momentum.

- **Hydraulic**
- **Electric**
- **Surge**

### 6. Principles of hydraulic-brake-system operation

- Hydraulic pressure is used to actuate the trailer brakes.
- Power for the hydraulic pump is normally provided by an electrical circuit powered by the tow vehicle's electrical system.
- When the tow-vehicle brakes are applied, electricity powers the hydraulic pump to move the brake piston, forcing the brake shoes against the drum.
- When the tow-vehicle brakes are released, power is removed from the hydraulic-piston actuator and a return mechanism, such as a spring, pulls the brake shoes back from the drum.

## Information Sheet

7. **Principles of electric-brake-system operation**

- When the tow-vehicle brakes are applied, an electrical circuit is closed so that the vehicle brake lights come on.
- The trailer lighting harness includes a connection between the tow-vehicle brake-light circuit and an electromagnetic circuit in the trailer brakes.
- When the tow-vehicle brakes are applied, the electromagnet in the trailer-brake circuit is switched on and a solenoid pushes the trailer's brake shoes against the drum.
- When the tow-vehicle brakes are released, the electromagnet in the trailer-brake circuit is switched off and a return mechanism, such as a spring, pulls the trailer's brake shoes back from the drum.

8. **Principles of surge-brake-system operation**

- The tow-vehicle brakes slow the tow vehicle and, thus, the trailer.
- The momentum of the trailer causes the surge brakes to engage.
- When the tow vehicle accelerates, the increase in speed causes the surge brakes to disengage.

9. **Typical service procedures required for trailers**

- **Pack wheel bearings**

  Note: It is particularly important to keep the wheel bearings on boat trailers well lubricated due to the fact that trailers may sit for long periods without use and the wheels are often submerged in water.

- **Replace, repair, or rotate tires**

  Note: Trailer tires are subject to deterioration because they are generally light-duty construction and are frequently submerged in water. They often sit in one position for long periods also.

- **Adjust or replace brake pads**
- **Replace lamps or electrical wiring**

  Note: The taillights on boat trailers often go in and out of the water, which can lead to rust and corrosion.

- **Lubricate mechanical parts such as the hitch or the tongue jack**

  Note: Be sure to use a water-resistant lubricant.

- **Adjust, repair, or replace bunks**
- **Replace rollers**

## Information Sheet

- **Adjust bow stop or tongue weight**

  Note: For proper towing and storage, the boat must sit properly on the trailer. The bow stop helps to balance the boat and keep it from sliding forward. Adjusting the tongue weight allows the positioning of the tongue so that the weight of the boat is properly distributed on the tow-vehicle bumper.

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Student Supplement 1—Guidelines for Outboard-Engine Boat-System Transport and Operation

**Introduction**

In addition to servicing boats and engines, the technician is often required to operate outboard-engine boat systems to diagnose problems or to test the performance of the craft after service or modifications. Operating the boat system also involves getting it to the water, which means that the craft must be placed on a trailer, towed to the test site, and launched. This supplement covers guidelines for these associated tasks, including:

- Selecting a trailer
- Towing a boat system
- Launching a boat
- Operating a boat
- Loading a boat

**Guidelines for selecting a trailer**

While service technicians will not generally have to make an independent decision about what trailer offers the best match for a given boat, they often have to evaluate which of a limited number of trailers available is best suited for transporting a specific boat system. In many instances, the technician may use the customer's trailer to haul a boat being serviced. In such cases, the service technician should assess the suitability of the owner's trailer for transporting the boat and should advise the customer of any problems in matching the boat and the trailer.

The major consideration in selecting a trailer for a boat is safety—that is, can the boat be adequately secured to the trailer and the trailer be towed without risk of an accident? The first concern is how well the boat and trailer match physically. The primary areas of interest include:

- **Load capacity**. Is the trailer rated to support the weight of the boat system? Remember, the weight of the boat system may be considerably more than the weight of the boat hull alone. In addition to the engine, the hull may be rigged with a fuel tank, steering system, canopy, additional seats, fishing accessories, communications and navigation equipment, and other items that can more than double the weight of the hull alone. Not only must the load capacity of the trailer be adequate to support this weight, but the tires must be the correct size, load capacity, and inflated pressure to accommodate the full load.

  Trailers carry labels, generally on the tongue, that list the load capacity of the trailer. Remember also that boat trailers are designed to carry the boat and its normal accessories but not excessive additional weight in the boat.

- **Length**. The trailer must be long enough so that the front of the boat meets the bow stop without hanging over the rear of the trailer excessively. If the boat protrudes too far beyond the rear of the trailer, a number of problems are likely to develop. There is a danger that the boat is not adequately supported and that the boat may come off the trailer. The rear of the boat may drag the road surface as the tow vehicle passes over dips and rises. If too much weight is to the rear of the trailer axles, the trailer may not follow the tow vehicle properly and may fishtail—weave from side to side.

- **Width**. The trailer must be wide enough so that the sides of the boat do not extend beyond the width of the axle. Specifically, the bunks or other supports must fit the side of the hull snugly to prevent the boat from tottering from side to side and high enough up on the sides of the boat so that the hull is supported against lateral movements.

- **Bottom support**. The trailer must provide support to the bottom of the hull appropriate to the shape of the hull. Specifically, the hull will have one or more keel ridges. Ideally, keel rollers will be provided for each keel. Cluster rollers or bunks should be located at a sufficient number of points along the hull so that the boat is not simply resting on the bow and stern. Also, the rollers and bunks must reduce friction enough to allow the boat to slide on and off the trailer during launching and loading. This means bunks must be properly surfaced and rollers must turn freely.

Other concerns for selecting a trailer include the following.

- **Bow stop**. The bow stop must provide a resting point for the bow that is adjustable to a height near the deckline.

- **Brakes**. If the trailer is equipped with brakes, the system must supplement the braking capacity of the tow vehicle so that the weight of the boat and trailer can be safely stopped.

- **Physical soundness**. The technician should inspect the trailer for physical defects, such as bent or rusted frame components, broken or cracked welds, damaged bunks and rollers, loose or missing hardware, worn hitch, bent or damaged tongue, worn or cracked links in the safety chain, frayed winch cable, bent or damaged axles, broken or "sprung" springs, etc. As noted before, the tires should be properly inflated, but the technician should also ensure that the tires are not excessively worn and that the rims are in good condition.

- **Lighting system**. Besides physically accommodating the boat, the trailer must have a working lighting system, including brake lights, taillights, and turn signals, as a minimum. The technician should ensure that the configuration of the boat and accessories such as boat covers do not obscure the visibility of the lights.

- **Proper match with the tow vehicle**. The trailer and the tow vehicle must be properly matched. The tow vehicle must be powerful enough to pull the loaded trailer at safe speeds. The vehicle must also have the braking capacity required to safely stop the vehicle and load. If the trailer has a brake system, the tow vehicle must be able to power that system. The connection between the trailer and tow-vehicle lighting systems must be compatible. The hitch components of the trailer and the tow vehicle must be of the same design and size. The technician should ensure also that the hitch-mounting hardware is properly secured.

**Guidelines for towing a boat system**

- **General guidelines for towing**. Technicians need to know the general guidelines for safe towing because they may have to tow a trailer after performing service on the trailer, or they may have to tow a boat on a trailer to take the boat to a launch site after performing service on the boat system.

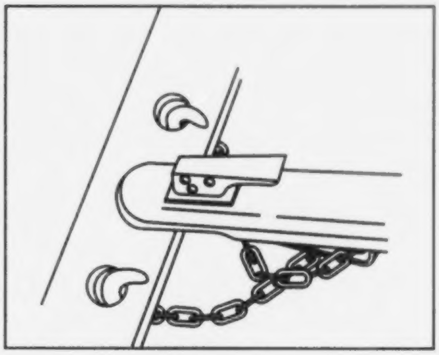
  — Ensure that the tow vehicle is capable of towing the trailer.

  — Ensure that the boat is properly secured to the trailer.

  — Ensure that the trailer is securely hitched to the tow vehicle.

  The tow vehicle must have a secure means of fastening to the trailer, and the trailer must have a secure means of fastening to the tow vehicle. Many systems have safety chains or other devices as added protection in the event that the trailer breaks loose from the tow vehicle (see Figure 1).

  **Figure 1:** Safety chains



  — Do not overload the trailer.

  Each trailer has a limited load capacity. The combined weight of the boat and the engine cannot exceed the load capacity of the trailer.

  — Ensure that the lights on the trailer are operable.

  Even if the trailer is not to be operated at night, the brake lights and turn signals are important safety features that must be operable.

  — Ensure that the trailer tires are properly inflated.

  The trailer tires are an important part of the suspension system and are critical to the support of the load. Much of this support is provided by the air pressure in the tires. Under- or overinflated tires overheat and are likely to blow or otherwise fail; they can also cause the trailer to track erratically, especially if the tires on one side of the trailer are drastically different in air pressure.

- Ensure that the trailer tires are not overly worn.
- Ensure that the trailer brake system is properly connected and operable.
- When operating the tow vehicle with the trailer attached, be especially aware of obstructed vision to the rear. Often, extended side mirrors on the tow vehicle may be required.
- Remember, the handling characteristics of the tow vehicle will be affected by the trailer load. The vehicle and trailer combination will require a wider turning radius, and there may be a tendency for the trailer to sway at certain speeds. Most importantly, the distance required to stop the vehicle and loaded trailer will be greater—more than twice as much under some circumstances. Additionally, stopping will be less stable with a greater tendency to deteriorate into a skid.
- Check to ensure that there will be nothing in the path of the trailer when you will be pulling forward or backing.
- Place blocks in front of and behind the wheels of the trailer whenever it is parked.

  Blocks prevent the trailer from rolling or shifting. If the trailer is parked on an incline or even if the trailer is parked on a flat surface, there is a danger that the trailer may be bumped or otherwise moved.
- Make sure that items in the boat are secured before traveling. At moderate speeds, light items such as life preservers and ice-chest lids are likely to blow out. Even at low speeds, fuel tanks, fishing equipment, and other loose items are likely to shift position and may become damaged or may damage other items.

• **General procedure for towing**. Usually, the technician will have no written instructions on how to tow an outboard-engine boat system on a trailer, and the specific procedure used can vary in many ways due to the differences in factors such as the type of boat used, the type of trailer used, the tow vehicle used, road conditions, etc. However, the technician must be familiar with the general towing procedure and then make him- or herself familiar with the specific procedures for a particular tow vehicle, boat, and trailer.

The following is the general procedure the technician should follow when preparing to tow an outboard-engine boat system.

1. Inspect the trailer to ensure that the tires are in good condition and properly inflated. Also check the general condition of the trailer, including the frame, weld joints, fasteners, boat supports, etc.

**Student Supplement 1**

2. Make sure the boat is properly loaded and secure on the trailer.
3. Ensure that the trailer wheels are properly blocked and that there are no obstacles between the tow vehicle and the trailer.
4. Ensure that the trailer hitch allows enough height to clear the bumper of the tow vehicle. A common hitch design is the ball-and-cup design in which a cavity in the trailer tongue fits over a ball on the hitch of the tow vehicle. Other designs are used and will affect the procedure for aligning the tow vehicle and trailer.
5. Position a spotter to help you align the tow-vehicle hitch with the trailer.
6. Back the tow vehicle into position to connect the hitch.
7. Set the tow-vehicle parking brake, place the transmission in gear or in park, and turn off the engine.
8. Connect the trailer tongue to the hitch.
9. Fasten the safety chain or other accessories by crisscrossing the chains under the coupler. The hook of the chain should go up under the hitch, and then, the hook should be pointed back toward the trailer (see Figure 1).
10. Install the electrical connection.
11. Remove the wheel blocks.
12. Release the tow-vehicle parking brake and pull the vehicle forward slightly; apply the tow-vehicle brakes. Have the spotter verify that the trailer brake lights work properly.
13. Turn on the tow-vehicle headlights, and have the spotter check to see that the trailer taillights and running lights are working.
14. Test the tow-vehicle left and right turn signals, and have the spotter ensure that the trailer turn signals are operating properly.
15. Place the tow vehicle in reverse and back the trailer a few feet to get a feel for how the trailer backs.
16. Place the tow vehicle in gear or park and turn off the engine.
17. Inspect the trailer hitch and trailer connection to ensure that they are still secure.
18. Return to the tow vehicle and pull forward at low speed. Try to turn to the left and right under controlled conditions to check the trailer's tracking and turning radius and the clearance between the vehicle and boat in a full turn.
19. Continue in a straight line to a speed of about 20 mph and apply the brakes to ensure that the tow vehicle and trailer stop easily.

## Student Supplement 1

### Guidelines for launching a boat

- **General guidelines for launching**. Prior to launching the boat, inspect it to be sure that no damage occurred to the boat or trailer during transport. For example, check the hull to ensure that it has not been cracked or punctured from rocks or road debris. Be sure that the engine is fully tilted and that the drain plug is in place.

  Boats should only be launched from approved ramps. Ensure that the ramp, including the water area, is free of obstacles. Before backing the trailer toward the water, release any holddowns on the boat, disconnect the trailer lights, and attach a towline to the bow and stern of the boat. Have someone hold the towlines and serve as a spotter.

  Use caution when backing the trailer and maintain communication with the spotter. Do not allow the trailer to get too deep in the water and do not allow the tow-vehicle rear wheels or tail pipe to enter the water. The boat should be launched using the bouyancy of the water as much as possible, allowing the boat to slide from the bow stop by letting rope out from the winch.

- **General procedure for launching**. The following is the general procedure the technician should follow when launching an outboard-engine boat system.

  1. Ensure that the launch area is clear of obstacles.
  2. Position the tow vehicle and trailer for the launch.
  3. Position a spotter to assist with the backing process.
  4. Release any hold-downs for the boat.
  5. Attach two towlines (one to the front and one to the rear) of the boat and have another person on shore hold the lines.
  6. Disconnect the trailer lights from the tow vehicle.
  7. Back the tow vehicle and trailer into the water to the point that the boat begins to float.

     Note: Be sure that the drain plugs are installed before backing the boat into the water.
  8. Stop the tow vehicle, place the transmission in gear or park, set the parking brake, and turn off the engine.
  9. Use a wheel block to block the front tire on one side of the tow vehicle.
  10. Release some rope from the trailer winch and slide the boat into the water until the boat clears the trailer.
  11. Board the boat and lower the engine into the water.
  12. Start the engine and ensure that water is flowing through the cooling system.

13. Disconnect the winch rope and move the boat clear of the trailer.

    Note: It may be possible to slide the boat from the trailer with a slight shove or by using the engine.

14. Secure the winch rope.

15. Remove the wheel block from the front tire of the tow vehicle.

16. Drive the tow vehicle forward to move the trailer out of the water.

Once the boat is clear of the trailer, it can be moved from the launch area with the towlines, paddles, or careful, low-speed operation of the engine. The trailer and tow vehicle can then be removed from the launch area and parked.

**Guidelines for operating a boat**

Two sets of guidelines apply to the operation of a boat when diagnosing a problem or testing boat performance after service. First, all the general guidelines for safe operation must be observed. Second, the technician must remain aware of the purpose of operating the boat—testing boat performance.

- **General guidelines for operating a boat**. In terms of overall safe boat operation, the technician should become familiar with the boat, the area where the boat is being operated, and the rules of boat operation specific to that area. There are some general rules of safe boat operation, such as those outlined by the U. S. Coast Guard. However, there may be specific restrictions for a particular body of water. For example, on some lakes, it is not permitted to operate a powered boat so as to cause a wake, to operate boats over certain lengths, or to operate powered boats at night. Such operational restrictions may apply to the entire lake or just to portions of it.

  As a minimum, a technician should adhere to the following guidelines:

  — Do not overload the boat.

    A boat can safely support a limited amount of weight without danger of sinking. A technician should not transport passengers unless absolutely necessary. If it is necessary, then the number of passengers and weight capacities must not be exceeded.

  — Observe all speed limits.

  — Observe all restricted-operation areas.

  — Be courteous; if in doubt, yield to other boaters.

  — Ensure that the boat has adequate safety devices, to include lite preservers for all passengers.

    Life jackets, belts, and other flotation devices must be available for each person in the boat. The flotation devices should be approved by the U. S. Coast Guard or a comparable regulatory agency.

— Observe weather conditions and operate the boat only when it is safe to do so.

If the weather is stormy or if the boat must be operated in high or swiftly running water, do not operate the boat. Operation by a technician is normally for test purposes only, so it should be done only when it can be done safely and when the test results cannot be overly affected by weather or water conditions.

- **General guidelines for testing boat performance**. Special precautions that should be observed when testing a boat include:

— Remember, you are operating property that belongs to someone else; treat it with care.

— Be sure that someone knows what your plans are, where you will operate the boat, and when you expect to get back.

— Be aware of the likely effects of the customer's complaint or the service modification on the boat to avoid overtaxing the boat system's operating limits.

— Get to know the boat thoroughly.

— Take along additional safety equipment, such as a fire extinguisher, radio, etc.

**Guidelines for loading a boat**

- **General guidelines for loading**. Loading the boat is similar to launching it except the procedure is done in reverse. Most of the same guidelines apply, such as not getting the tow-vehicle wheels in the water. Additionally, the following specific guidelines should be observed.

— Raise the engine.

— Do not use engine power to drive the boat onto the trailer.

— Ensure that the winch rope or cable is secure before pulling the trailer from the water.

— Once the trailer and boat are clear of the water, park the tow vehicle, placing the transmission in PARK or in gear, setting the parking brake, and cutting off the engine.

— Secure the boat and inspect it before traveling; be especially careful to check the security of the engine mounting and condition of the transom.

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Assignment Sheet 1—Determine Trailer Specifications and Parts Requirements

Name ______________________________ Date ____________________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

**Introduction**

Outboard-engine technicians are often called upon to service other components of boat systems, including the trailers that are used to transport boats. Trailers have to be matched to the boat in terms of length, load capacity, width, bow stop, braking capacity, etc. Many of the characteristics of a trailer can be adjusted to accommodate a particular boat. In some cases, a trailer may undergo substantial changes, such as different wheel diameters, heavier wheel bearings, a different light system, etc. A technician may be called upon to provide various types of trailer service. In this assignment sheet, you will practice selecting parts and determining specifications for boat trailers.

**Exercise**

**Directions**

For this assignment, your instructor will assign you five trailers to use to complete the exercise. Using the resources available in your facility, determine the part numbers and specifications requested for each trailer. Write your answers on the blanks provided with each item.

## Assignment Sheet 1

**Part A** **Trailer 1**

1. Make and model of trailer — ______
2. Length, width, and load capacity — ______
3. Braking capacity — ______
4. Part number for wheel bearing — ______
5. Size of hitch ball — ______
6. Size of tires and recommended inflation — ______
7. Part number for brake-light bulb — ______
8. Torque value for wheel bearings — ______
9. Part number for brake shoes (or pads) — ______
10. Recommended winch lubricant — ______
11. Other service requirements — ______

## Assignment Sheet 1

### Part B Trailer 2

1. Make and model of trailer —
2. Length, width, and load capacity —
3. Braking capacity —
4. Part number for wheel bearing —
5. Size of hitch ball —
6. Size of tires and recommended inflation —
7. Part number for brake-light bulb —
8. Torque value for wheel bearings —
9. Part number for brake shoes (or pads) —
10. Recommended winch lubricant —
11. Other service requirements —

## Assignment Sheet 1

**Part C** **Trailer 3**

1. Make and model of trailer — ______________________________

2. Length, width, and load capacity — ______________________________

3. Braking capacity — ______________________________

4. Part number for wheel bearing — ______________________________

5. Size of hitch ball — ______________________________

6. Size of tires and recommended inflation — ______________________________

7. Part number for brake-light bulb — ______________________________

8. Torque value for wheel bearings — ______________________________

9. Part number for brake shoes (or pads) — ______________________________

10. Recommended winch lubricant — ______________________________

11. Other service requirements — ______________________________

## Assignment Sheet 1

### Part D Trailer 4

1. Make and model of trailer —
2. Length, width, and load capacity —
3. Braking capacity —
4. Part number for wheel bearing —
5. Size of hitch ball —
6. Size of tires and recommended inflation —
7. Part number for brake-light bulb —
8. Torque value for wheel bearings —
9. Part number for brake shoes (or pads) —
10. Recommended winch lubricant —
11. Other service requirements —

## Assignment Sheet 1

**Part E** **Trailer 5**

1. Make and model of trailer — ______________________________

2. Length, width, and load capacity — ______________________________

3. Braking capacity — ______________________________

4. Part number for wheel bearing — ______________________________

5. Size of hitch ball — ______________________________

6. Size of tires and recommended inflation — ______________________________

7. Part number for brake-light bulb — ______________________________

8. Torque value for wheel bearings — ______________________________

9. Part number for brake shoes (or pads) — ______________________________

10. Recommended winch lubricant — ______________________________

11. Other service requirements — ______________________________

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Assignment Sheet 2—Select Trailers for Outboard-Engine Boat Systems

Name ______________________________ Date ____________

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| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

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**Introduction**

Outboard-engine technicians often have to test the results of their work by operating a boat system, especially when the work involves mounting an engine or rigging certain systems. Consequently, the technician must know how to transport the boat to the test area. This generally requires the use of a trailer, which must be properly matched to the boat. Some of the considerations that must be made include the load capacity of the trailer, whether it is the proper length, whether the trailer design is compatible with the hull design, how the boat is to be supported, whether the trailer adjustments (bunks, bow stop, etc.) can provide adequate support, and similar concerns.

**Exercise**

**Directions**

Read Student Supplement 1, "Guidelines for Outboard-Engine Boat-System Transport and Operation." Then, your instructor will complete Items 1 through 4 in the "Instructor-provided information" section on the next pages to identify two boat systems for you—each boat system will be either one in your facility or one based on specific boat and engine designs. Your instructor will also identify a selection of three boat trailers—again, either actual trailers in your facility or trailers available in catalogs or dealerships. You will complete the information requested in Item 1 in the "Technician-provided information" section for each boat system. From the three trailers your instructor identifies, choose the trailer best suited for transporting the assigned boat system and then explain your decision.

## Assignment Sheet 2

**Part A** **Boat-system 1**

Instructor-provided information

1. Boat description: Hull style — ____________________

Length — ____________________

Engine make and model — ____________________

2. Trailer 1 —

Trailer description: Make and model — ____________________

____________________

Length — ____________________

Bow-stop adjustment — ____________________

Trailer-weight adjustment — ____________________

3. Trailer 2 —

Trailer description: Make and model — ____________________

Length — ____________________

Bow-stop adjustment — ____________________

Trailer-weight adjustment — ____________________

4. Trailer 3 —

Trailer description: Make and model — ____________________

Length — ____________________

Bow-stop adjustment — ____________________

Trailer-weight adjustment — ____________________

Technician-provided information

1. Which of the three trailers described above would you select for the boat system your instructor has described? Explain your reasons for selecting that trailer.

____________________

____________________

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## Assignment Sheet 2

**Part B** **Boat-system 2**

Instructor-provided information

1. Boat description: Hull style — ______________________
   Length — ______________________
   Engine make and model — ______________
2. Trailer 1 —
   Trailer description: Make and model — ________________
   ______________________________
   Length — ______________________
   Bow-stop adjustment — ______________
   Trailer-weight adjustment — ____________
3. Trailer 2 —
   Trailer description: Make and model — ________________
   Length — ______________________
   Bow-stop adjustment — ______________
   Trailer-weight adjustment — ____________
4. Trailer 3 —
   Trailer description: Make and model — ________________
   Length — ______________________
   Bow-stop adjustment — ______________
   Trailer-weight adjustment — ____________

---

Technician-provided information

1. Which of the three trailers described above would you select for the boat system your instructor has described? Explain your reasons for selecting that trailer.

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# Trailers and Safe Towing and Boat Operation
## Unit 2

### Assignment Sheet 3—Inspect Trailers

Name ______________________________ Date ______________

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| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

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**Introduction**

This assignment sheet covers the inspection of outboard-engine boat trailers. This is a general inspection of the safety, physical condition, security, and general functioning of the trailer. The inspection includes the general condition of the trailer structure, wheel and tire assemblies, lighting systems, and hitch. The exact steps for the inspection will depend on the trailer design and the installed support systems. Some general aspects of the inspection include

- Cracks in weld joints, bent frame components, loose hardware, rust and corrosion, and other defects in the frame and support structure.
- Wear, misalignment, looseness, poor lubrication, and damage to moving parts.
- Defects in electrical, hydraulic, or mechanical subsystems for brakes, lighting, etc.
- General condition of the overall system.

**Exercise**

**Directions**

First, read Student Supplement 1, "Guidelines for Outboard-Engine Boat-System Transport and Operation." Next, have your instructor provide you with two outboard-engine boat-system trailers. Then, inspect these trailers and record your findings by completing the inspection checklists on the following pages.

## Assignment Sheet 3

### Part A Trailer-system 1 inspection checklist

1. Trailer load capacity and length —
2. Type, size, and condition of hitch —
3. Describe the condition of the tongue, winch, and tongue jack. (Any cracks, wear, frayed rope or cable, damage, inadequate lubrication, corrosion, load-capacity label missing or not readable, loose or missing hardware, etc.?)
4. Describe the condition of the frame. (Any cracks in weld joints, cracked or bent tubing, loose or missing hardware, etc.?)
5. Describe the condition of the boat support system. (Any missing or worn bunks, rails, or rollers; rollers that will not turn; loose or missing hardware; bow stop or tilt controls that will not adjust, etc.?)
6. Describe the condition of the suspension system. (Any bent or broken springs, worn or leaking shock absorbers, loose or missing hardware, etc.?)

## Assignment Sheet 3

7. Describe the condition of the tire and wheel assemblies. (Any tire wear or poor conditions, improper tire inflation, loose or missing hardware, bearings inadequately lubricated, etc.?)

8. Describe the condition of the brake system. (Any worn pads or shoes, deformed or worn drums or rotors, loose or missing hardware, improper condition or operation of electrical or hydraulic components?)

9. Describe the condition of the lighting system. (Any bulbs not working, improper system operation, loose or missing hardware, broken or damaged lenses, improper wiring condition, etc.?)

10. Identify and describe to the trailer owner any other recommendations you would make regarding the condition of the trailer, its service requirements, and its fitness for service.

## Assignment Sheet 3

**Part B** **Trailer-system 2 inspection checklist**

1. Trailer load capacity and length — ____________________
2. Type, size, and condition of hitch — ____________________
3. Describe the condition of the tongue, winch, and tongue jack. (Any cracks, wear, frayed rope or cable, damage, inadequate lubrication, corrosion, load-capacity label missing or not readable, loose or missing hardware, etc.?)
4. Describe the condition of the frame. (Any cracks in weld joints, cracked or bent tubing, loose or missing hardware, etc.?)
5. Describe the condition of the boat support system. (Any missing or worn bunks, rails, or rollers; rollers that will not turn; loose or missing hardware; bow stop or tilt controls that will not adjust, etc.?)
6. Describe the condition of the suspension system. (Any bent or broken springs, worn or leaking shock absorbers, loose or missing hardware, etc.?)

## Assignment Sheet 3

7. Describe the condition of the tire and wheel assemblies. (Any tire wear or poor conditions, improper tire inflation, loose or missing hardware, bearings inadequately lubricated, etc.?)

8. Describe the condition of the brake system. (Any worn pads or shoes, deformed or worn drums or rotors, loose or missing hardware, improper condition or operation of electrical or hydraulic components?)

9. Describe the condition of the lighting system. (Any bulbs not working, improper system operation, loose or missing hardware, broken or damaged lenses, improper wiring condition, etc.?)

10. Identify and describe to the trailer owner any other recommendations you would make regarding the condition of the trailer, its service requirements, and its fitness for service.

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Assignment Sheet 4—Complete a Boat-Safety Exam

Name ______________________________ Date ______________

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| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | _______ |
| Minimum of 85 percent of answers are correct. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** ______________________________

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**Introduction**

Many types of power product equipment are hand tools or operator-driven equipment that are not used in public traffic. However, some types of equipment, such as motorcycles and outboard-engine boats, are intended to be operated on public thoroughfares. Operation under these conditions requires a knowledge of how to operate the vehicle and how to operate it safely. Because technicians often have to operate outboard-engine boat systems in order to diagnose problems and to test performance after service, they must be familiar with safe boat-system operation. One commonly used resource material for helping boaters understand boat safety is the U.S. Coast Guard booklet *Federal Requirements and Safety Tips for Recreational Boats*. Other resource materials are provided by your state's boating-law administrating agency.

**Exercise**

**Directions**

Your instructor will provide you with the latest edition of the safety information provided by the U.S. Coast Guard and/or your state's boating-law administrating agency.

Study this information, and then take the sample safety exam in this assignment sheet. Answer each of the following items. Write an "X" in the blank before the correct answer with each test item and then explain your answer and cite the source of your information on the blanks provided below each question.

## Assignment Sheet 4

**Sample safety exam**

1. Where must the registration number of a boat appear on the hull?

________ a. On the front half of the boat on the left side only

________ b. On the aft half of the boat on the left side only

________ c. On the front half of the boat on both sides

________ d. On the rear half of the boat on both sides

Explain your answer and cite the source of your information on the blanks below.

________________________________________________

________________________________________________

________________________________________________

________________________________________________

________________________________________________

________________________________________________

________________________________________________

2. What VHF-FM radio channel is used for emergency transmissions?

________ a. 13

________ b. 14

________ c. 15

________ d. 16

Explain your answer and cite the source of your information on the blanks below.

________________________________________________

________________________________________________

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## Assignment Sheet 4

3. Which of the following actions would be considered negligent or grossly negligent operation of a vessel?

_______ a. Operating a boat in a swimming area

_______ b. Insufficient fire extinguishers on board

_______ c. Both of the above

_______ d. Neither of the above

Explain your answer and cite the source of your information on the blanks below.

________________________________________

________________________________________

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________________________________________

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________________________________________

________________________________________

4. If a person dies or receives injuries requiring more than first aid as a result of a boating accident, how soon must a formal report be filed?

_______ a. Within 24 hours

_______ b. Within 48 hours

_______ c. Within one week

_______ d. Any time during that boat-registration year

Explain your answer and cite the source of your information on the blanks below.

________________________________________

________________________________________

________________________________________

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________________________________________

________________________________________

## Assignment Sheet 4

5. Which of the following "musts" is **not** a requirement for wearable personal flotation devices (PFDs)?

   ________ a. PFDs must be Coast Guard-approved.

   ________ b. PFDs must be in good and serviceable condition.

   ________ c. PFDs must be of the appropriate size for the intended wearer.

   ________ d. PFDs must be protected by storing them in plastic bags and keeping them in closed compartments if they are not worn during operation of the vessel.

   Explain your answer and cite the source of your information on the blanks below.

6. Which of the following is true with regard to the number of PFDs required when operating a vessel?

   ________ a. Boats less than 16 feet in length are not required to carry PFDs.

   ________ b. Boats longer than 16 feet are required to have one Type I PFD for each person on board.

   ________ c. Boats longer than 16 feet are required to have one Type I PFD *and* one Type IV PFD for each person on board.

   ________ d. If a Type V PFD is to be counted toward the minimum carriage requirements, it must be worn.

   Explain your answer and cite the source of your information on the blanks below.

## Assignment Sheet 4

7. What color of flag is used for a daytime distress signal?

   _______ a. Red

   _______ b. Orange

   _______ c. Yellow

   _______ d. Black

   Explain your answer and cite the source of your information on the blanks below.

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

8. Technician A says that all outboard-engine boats are required to carry fire extinguishers. Technician B says that outboard-engine boats that have permanently mounted fuel tanks are required to carry fire extinguishers. Who is correct?

   _______ a. Technician A

   _______ b. Technician B

   _______ c. Both Technician A and Technician B

   _______ d. Neither Technician A nor Technician B

   Explain your answer and cite the source of your information on the blanks below.

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

   ______________________________________________________________

## Assignment Sheet 4

9. What class of fire extinguisher is recommended for use on boats?

_______ a. A

_______ b. B

_______ c. C

_______ d. D

Explain your answer and cite the source of your information on the blanks below.

10. When are boats required to have ventilation systems?

_______ a. If they use gasoline to generate electricity

_______ b. If they use gasoline to provide mechanical power

_______ c. If they use gasoline to propel the boat

_______ d. All of the above

Explain your answer and cite the source of your information on the blanks below.

## Assignment Sheet 4

11. Technician A says that all boats over 16 feet in length must have backfire flame-control devices on their engines. Technician B says that boat owners are responsible for ensuring that their boats are properly ventilated. Who is correct?

_______ a. Technician A

_______ b. Technician B

_______ c. Both Technician A and Technician B

_______ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

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12. Technician A says that outboard-engine boats must display navigation lights between sunset and sunrise. Technician B says that outboard-engine boats must display navigation lights during periods of reduced visibility, such as heavy fog. Who is correct?

_______ a. Technician A

_______ b. Technician B

_______ c. Both Technician A and Technician B

_______ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

______________________________

______________________________

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______________________________

## Assignment Sheet 4

13. With regard to a boat operator's facing forward, what color of navigation light should be used on the left side of the bow?

_____ a. Red

_____ b. Green

_____ c. White

_____ d. None of the above

Explain your answer and cite the source of your information on the blanks below.

14. If two vessels are approaching each other head-on, what action should be taken?

_____ a. The vessels should pass each other starboard to starboard.

_____ b. The vessels should pass each other port to port.

_____ c. The vessel nearer to shore should stop and yield to the other vessel.

_____ d. The vessel farther from shore should stop and yield to the other vessel.

Explain your answer and cite the source of your information on the blanks below.

## Assignment Sheet 4

15. Technician A says that the person in charge of a vessel is obligated by law to provide assistance that can be safely provided to any individual in danger at sea. Technician B says that the person in charge is subject to a fine and/or imprisonment for failure to do so. Who is correct?

_______ a. Technician A

_______ b. Technician B

_______ c. Both Technician A and Technician B

_______ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Job Sheet 1—Perform Routine Maintenance on Trailers

### Introduction

This job sheet covers the routine maintenance associated with trailers. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Inspect components, including mechanical, hydraulic, and electrical components
- Lubricate bearings, hitches, and other moving parts
- Adjust wheel bearings (preload) and brakes
- Adjust bow stop and tongue weight
- Adjust tire pressure

Note: Some routine procedures may not be covered in service manuals. In many cases, you will be able to apply techniques that you have learned with other types of equipment in the maintenance of a trailer. For example, adjusting tire pressure may not be explained in a service manual but is similar to the procedure for lawn and garden equipment.

### Procedure

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of performing routine maintenance on trailers and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one trailer. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a trailer.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 1

## Worksheet—Perform Routine Maintenance on Trailers

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 1

## Worksheet—Perform Routine Maintenance on Trailers

---

**Part B:** **Performance evaluation**

**Evaluation criteria** **Rating**

Correct procedures identified for assigned equipment. ________

Procedures completed correctly. ________

Proper tools used correctly. ________

Safety precautions observed. ________

Service meets specifications. ________

Clean-up and follow-up actions adequate. ________

**Overall rating** ________

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

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# Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 2—Repair Trailers

**Introduction** This job sheet covers the procedures associated with repairing trailers. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Replace trailer components, including mechanical, electrical, and hydraulic components
- Overhaul trailer subsystems, including tilt systems, brake systems, electrical systems, etc.
- Perform adjustments to return trailer systems to original operating specifications

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of repairing trailers and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one trailer. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a trailer that requires repair.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 2

## Worksheet—Repair Trailers

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 2

## Worksheet—Repair Trailers

---

**Part B: Performance evaluation**

**Evaluation criteria** **Rating**

Correct procedures identified for assigned equipment. ________

Procedures completed correctly. ________

Proper tools used correctly. ________

Safety precautions observed. ________

Service meets specifications. ________

Clean-up and follow-up actions adequate. ________

**Overall rating** ________

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 3—Safely Tow Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely towing outboard-engine boats. There is no specific procedure on how to tow a boat and trailer. The procedure can vary in many ways due to the differences in the boat used, the trailer used, the tow vehicle, road conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the trailer is properly secured to the tow vehicle, and that the lights are connected and working.
- Ensure that the boat is properly secured to the trailer.
- Be aware of the height of the boat compared to the height of the tow vehicle.
- Do not overload past the capacity of the trailer, the hitch, or the tow vehicle.

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely towing outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system and tow vehicle.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 3

## Worksheet—Safely Tow Outboard-Engine Boats

Name ______________________ Attempt number __________

Date ______________________

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________

  Type and size of boat and engine ______________________

  Type of tow vehicle ______________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned towing procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 3

## Worksheet—Safely Tow Outboard-Engine Boats

---

**Part B: Performance evaluation**

**Evaluation criteria** **Rating**

Procedures completed correctly. ________

Equipment operated correctly. ________

Safety precautions observed. ________

Clean-up and follow-up actions adequate. ________

**Overall rating** ________

**Evaluator's comments** ____________________________________________

____________________________________________

____________________________________________

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Job Sheet 4—Safely Launch Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely backing trailers and launching outboard-engine boats. There is no specific procedure on how to back a trailer and launch a boat. The procedure can vary in many ways due to the differences in the boat used, the trailer used, the tow vehicle, site conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the boat was not damaged during transport.
- Disconnect the trailer lights before backing the trailer into the water.
- Launch the boat only in an approved ramp area.
- Do not allow the trailer to get too low in the water or allow the tow vehicle to enter the water.
- Ensure that the engine is raised or that it will not strike any obstacles or surfaces.
- Ensure that the drain plug is in place.

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely launching outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system on a trailer and tow vehicle.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 4

## Worksheet—Safely Launch Outboard-Engine Boats

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________________

  Type and size of boat and engine ______________________________

  Type of tow vehicle ______________________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned launching procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 4

## Worksheet—Safely Launch Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Procedures completed correctly. | ______ |
| Equipment operated correctly. | ______ |
| Safety precautions observed. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 5—Safely Operate Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely operating outboard-engine boats. There is no specific procedure on how to safely operate outboard-engine boats. The procedure can vary in many ways due to the differences in the boat used, lake conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the boat has adequate safety devices, including personal flotation devices, operable lights and horns, etc.
- Observe all speed limits and rules of operation specific to the area
- Observe weather conditions
- Operate the boat within its limits

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely operating outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 5

## Worksheet—Safely Operate Outboard-Engine Boats

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Type and size of boat ______________________

  Type and size of engine ______________________

- Inspect the boat and engine and describe the results of your inspection.

- Describe conditions on the body of water.

- Describe your planned operation procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 5

## Worksheet—Safely Operate Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Procedures completed correctly. | ______ |
| Equipment operated correctly. | ______ |
| Safety precautions observed. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________

________________________________________

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 6—Safely Load Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely loading outboard-engine boats. There is no specific procedure on how to load a boat on a trailer. The procedure can vary in many ways due to the differences in the boat used, the trailer used, the tow vehicle, site conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the boat and trailer are compatible with one another.
- Do not approach the trailer with the boat under power.
- Ensure that the boat is properly secured before pulling the trailer out of the water.
- Do not allow the trailer to get too low into the water.
- Tilt the engine up before pulling the boat from the water.

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely loading outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system and tow vehicle with trailer.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 6

## Worksheet—Safely Load Outboard-Engine Boats

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________

  Type and size of boat and engine ______________________

  Type of tow vehicle ______________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned loading procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 6

## Worksheet—Safely Load Outboard-Engine Boats

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Equipment operated correctly. | ______ |
| Safety precautions observed. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

# Seasonal Procedures
# Unit 3

## Objective Sheet

### Unit objective

After completing this unit, the student should be able to describe the purposes of and perform seasonal-service procedures for outboard-engine boat systems. The student should demonstrate these competencies by completing the assignment sheet and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific objectives

After completing this unit, the student should be able to

1. Define the seasonal procedures required for outboard-engine boat systems.
2. State the purposes of winterizing outboard-engine boat systems.
3. State the purposes of adding stabilizers when winterizing outboard-engine boat systems.
4. Define the term *fogging*.
5. Describe the fogging process.
6. List the typical service procedures required for winterizing outboard-engine boat systems.
7. State the purposes of summerizing outboard-engine boat systems.
8. List the typical service procedures required for summerizing outboard-engine boat systems.
9. Determine seasonal-service specifications for outboard-engine boat systems. (Assignment Sheet 1)
10. Winterize outboard-engine boat systems. (Job Sheet 1)
11. Summerize outboard-engine boat systems. (Job Sheet 2)

# Seasonal Procedures
## Unit 3

### Information Sheet

1. **Seasonal procedures required for outboard-engine boat systems and their definitions**

   - **Winterizing**—Those actions taken to protect a boat system from the effects of exposure to low temperatures and other weather conditions during storage

   - **Summerizing**—Those actions taken to return a boat system to peak operating condition after it has been stored

2. **Purposes of winterizing outboard-engine boat systems**

   Note: There are two aspects of winterizing: (1) protecting the engine and the engine-support systems and (2) protecting the boat's hull. The exact tasks performed during winterizing vary according to the boat system and to the severity of the winter.

   - **To prevent corrosion of engine parts such as piston rings, cylinder walls, and bearing surfaces**

   - **To prevent clogged fuel systems due to varnish and other deposits**

     Note: During storage, gasoline breaks down and can become contaminated with water due to condensation. Some of the by-products of the breakdown of gasoline are varnish and other residues that solidify and can clog fuel lines, carburetor ports, and other openings.

   - **To prevent engine-support-system damage caused by water expansion due to freezing**

     Examples: Water pump and water tube

   - **To keep the battery from discharging**

   - **To reduce boat-system damage due to condensation and low temperatures**

   - **To prevent boat-system damage caused by exposure to the elements**

     Examples: Hull corrosion and cracking, rot, barnacles

3. **Purposes of adding stabilizers when winterizing outboard-engine boat systems**

   - **To delay the breakdown of fuel**

     Note: To reduce the chemical breakdown of gasoline during storage periods, additives can be added to the fuel system. These additives are normally referred to as *stabilizers* or *fuel conditioners*. Typically, one ounce of stabilizer is added to each gallon of fuel to prolong the service life of the fuel for up to one year.

## Information Sheet

- **To eliminate the need to drain the fuel tank during winterizing**

  Note: If a stabilizing additive is not added to the fuel system, then an alternate procedure is to drain the tank and run the engine until it is out of fuel. While this does prevent the buildup of some deposits, there are several drawbacks to draining the fuel system. Leaving the fuel system dry can lead to deterioration of flexible parts such as hoses and the fuel-pump diaphragm. Running the engine out of fuel—especially two-stroke-cycle engines—can damage the engine. There are also safety and environmental issues: (1) handling fuel is always dangerous and (2) the removed fuel is generally not usable elsewhere and must be disposed of.

### 4. Definition of the term *fogging*

- **Fogging**—Process for coating the internal engine parts to prevent rust and corrosion

### 5. Description of the fogging process

- Operate the engine with the lower unit submerged in clean water to provide adequate cooling.
- Run the engine while injecting rust-preventative oil into the carburetor until the engine smokes excessively.

  Note: If the engine is equipped with fuel injectors, the oil should be sprayed into the vapor separator tank.

### 6. Typical service procedures required for winterizing outboard-engine boat systems

- Add stabilizer or drain fuel system
- Add rust-preventative oil to engine through fogging
- Remove portable fuel tank
- Disconnect spark-plug lead
- Remove and store battery
- Clean and lubricate propeller shaft
- Change lower-unit lubricant
- Touch up paint and finishes
- Apply protective finish to external surfaces

  Example: Marine-grade wax
- Cover or store boat

## Information Sheet

7. **Purposes of summerizing outboard-engine boat systems**

   - To undo the steps taken to prepare the boat system for storage
   - To restore the engine and boat to peak operating performance
   - To prepare the trailer for safe highway operation and secure transport of the boat

8. **Typical service procedures required for summerizing outboard-engine boat systems**

   - Check lubricant and other fluid levels
   - Check for fluid leaks
   - Check battery
   - Check engine operation
   - Check warning systems
   - Check lights and running lights on boat and trailer
   - Check trailer tire pressure

# Seasonal Procedures
# Unit 3

## Assignment Sheet 1—Determine Seasonal-Service Specifications for Outboard-Engine Boat Systems

Name ______________________________ Date ______________

---

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________

______________________________

______________________________

---

**Introduction**

While there are some general principles of seasonal service that are basic to most boat systems, details such as the types of lubricants and protective finishes to use vary with different systems. Specifications for spark plugs, idle speeds, tension adjustments, and other factors differ for different engines and applications. In order to provide proper seasonal storage, a technician must be able to determine the correct specifications for the service. In this assignment sheet, you will practice determining specifications for equipment that may be required for seasonal service.

**Exercise**

**Directions**

Your instructor will fill out Items 1 through 3 in the "Instructor-provided information" section for Parts A through E of this assignment. You will use the resources available in your facility to complete Items 1 through 5 in the "Technician-provided information" section to determine the winterizing and summerizing specifications for each outboard-engine boat system your instructor has identified. Write your answers on the blanks provided with each item.

## Assignment Sheet 1

**Part A** **Boat-system 1**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

Make —
Model —
Type —

2. What is the make, length, and load capacity of the trailer?

Make —
Length —
Capacity —

3. What is the make, model, and type of engine?

Make —
Model —
Type —

Technician-provided information

1. Describe the overall winterizing process.

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

3. Describe the summerizing process.

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

5. What service should be performed on the trailer?

## Assignment Sheet 1

**Part B** **Boat-system 2**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

   Make — ____________________

   Model — ____________________

   Type — ____________________

2. What is the make, length, and load capacity of the trailer?

   Make — ____________________

   Length — ____________________

   Capacity — ____________________

3. What is the make, model, and type of engine?

   Make — ____________________

   Model — ____________________

   Type — ____________________

Technician-provided information

1. Describe the overall winterizing process.

   ____________________

   ____________________

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

   ____________________

   ____________________

3. Describe the summerizing process.

   ____________________

   ____________________

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

   ____________________

   ____________________

5. What service should be performed on the trailer?

   ____________________

   ____________________

## Assignment Sheet 1

**Part C** **Boat-system 3**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

Make —

Model —

Type —

2. What is the make, length, and load capacity of the trailer?

Make —

Length —

Capacity —

3. What is the make, model, and type of engine?

Make —

Model —

Type —

Technician-provided information

1. Describe the overall winterizing process.
2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?
3. Describe the summerizing process.
4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?
5. What service should be performed on the trailer?

## Assignment Sheet 1

**Part D** **Boat-system 4**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

Make — ____________________

Model — ____________________

Type — ____________________

2. What is the make, length, and load capacity of the trailer?

Make — ____________________

Length — ____________________

Capacity — ____________________

3. What is the make, model, and type of engine?

Make — ____________________

Model — ____________________

Type — ____________________

Technician-provided information

1. Describe the overall winterizing process.

____________________

____________________

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

____________________

____________________

3. Describe the summerizing process.

____________________

____________________

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

____________________

____________________

5. What service should be performed on the trailer?

____________________

____________________

## Assignment Sheet 1

**Part E**

### Boat-system 5

Instructor-provided information

1. What is the make, model, and type of boat assigned?

   Make —

   Model —

   Type —

2. What is the make, length, and load capacity of the trailer?

   Make —

   Length —

   Capacity —

3. What is the make, model, and type of engine?

   Make —

   Model —

   Type —

Technician-provided information

1. Describe the overall winterizing process.

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

3. Describe the summerizing process.

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

5. What service should be performed on the trailer?

# Seasonal Procedures
# Unit 3

## Job Sheet 1—Winterize Outboard-Engine Boat Systems

**Introduction**

This job sheet covers the procedure for winterizing outboard-engine boat systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Stabilize fuel or drain fuel system
- Fog engine
- Remove and inspect portable fuel tank
- Drain water from the engine
- Disconnect spark-plug lead
- Perform visual inspection of boat system
- Remove and store battery
- Drain and lubricate lower unit
- Touch up paint and finishes
- Apply protective finishes to external surfaces
- Cover or store boat

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheet.

2. Watch your instructor's demonstration of winterizing outboard-engine boat systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system to winterize.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 1

## Worksheet—Winterize Outboard-Engine Boat Systems

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 1

## Worksheet—Winterize Outboard-Engine Boat Systems

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________________________

______________________________________________

______________________________________________

# Seasonal Procedures
## Unit 3

### Job Sheet 2—Summerize Outboard-Engine Boat Systems

**Introduction** This job sheet covers the procedures for summerizing outboard-engine boat systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Inspect boat and trailer
- Replace spark plugs
- Check lubricant and fluid levels
- Test and charge battery, as necessary
- Check operation of fuel system
- Check operation of thermostat and cooling system
- Check warning systems
- Perform adjustments to return equipment to original specifications

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheet.
2. Watch your instructor's demonstration of summerizing outboard-engine boat systems and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one outboard-engine boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system to summerize.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 2

## Worksheet—Summerize Outboard-Engine Boat Systems

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 2

## Worksheet—Summerize Outboard-Engine Boat Systems

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | _______ |
| Procedures completed correctly. | _______ |
| Proper tools used correctly. | _______ |
| Safety precautions observed. | _______ |
| Service meets specifications. | _______ |
| Clean-up and follow-up actions adequate. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

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**Engine Systems and Service**

Section A: Engine Systems

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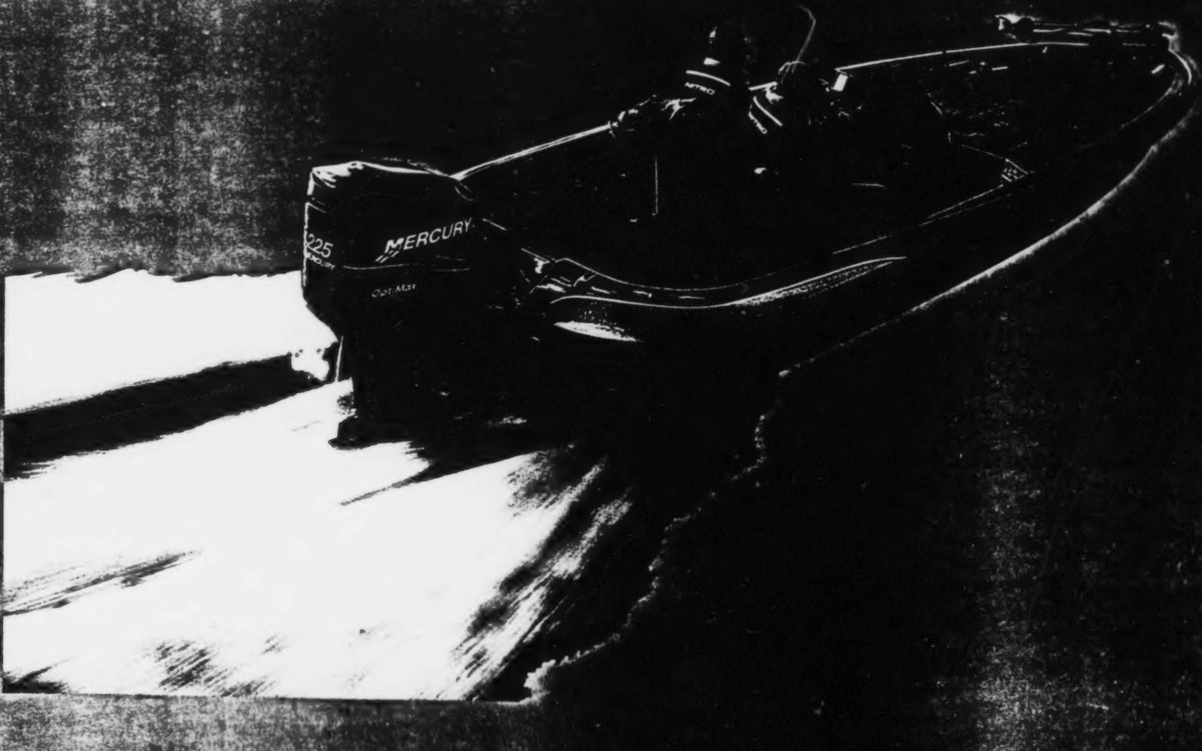
## Outboard-Engine Boat Systems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# Power Product Equipment Technician:

# Outboard-Engine Boat Systems

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Student Edition

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# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

## Objective Sheet

### Unit objective

After completing this unit, the student should be able to identify the major components of outboard-engine boat systems and select parts and accessories for, rig, and inspect an outboard-engine boat. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific objectives

After completing this unit, the student should be able to

1. List the characteristics used to classify boat systems.
2. Define the term *outboard-engine boat system.*
3. Match the major components of outboard-engine boat systems to their correct definitions.
4. Define directional terms used for boat systems.
5. Define types of hull conditions and defects.
6. Label common types of hardware used with rigging and accessories.
7. State the purposes of common types of instruments and gauges used on outboard-engine boat systems.
8. State the purposes of common types of electrical accessories used on outboard-engine boat systems.
9. Define common types of corrosion-protection systems.
10. State the purposes of common types of hardware accessories used on outboard-engine boat systems.
11. List the typical procedures performed when rigging outboard-engine boat systems.
12. Determine specifications for selecting and installing outboard engines. (Assignment Sheet 1)
13. Determine specifications and parts requirements for rigging and accessories for outboard-engine boat systems. (Assignment Sheet 2)
14. Inspect outboard-engine boat systems and rigging. (Assignment Sheet 3)
15. Install and adjust outboard engines. (Job Sheet 1)
16. Install and adjust remote engine-control assemblies. (Job Sheet 2)
17. Install and adjust steering systems. (Job Sheet 3)

## Objective Sheet

18. Install tank-to-engine fuel lines. (Job Sheet 4)
19. Install remote oil tanks. (Job Sheet 5)
20. Service and install batteries. (Job Sheet 6)
21. Install and adjust pitot systems. (Job Sheet 7)
22. Install and adjust transducer systems. (Job Sheet 8)
23. Install and adjust instruments and gauges. (Job Sheet 9)
24. Install and adjust electrical accessories. (Job Sheet 10)
25. Install and adjust hardware accessories. (Job Sheet 11)

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Information Sheet

1. **Characteristics used to classify boat systems**

- **Hull type**

  Note: There are two general types of hulls: (1) displacement and (2) planing. With a displacement hull, the boat displaces the same amount of water whether it is moving or at rest. In other words, the portion of the boat that is under water is approximately the same when the boat is moving or at rest. With a planing hull, the boat rises in the water as its speed increases—it displaces more water while at rest than while moving. Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," provides a more-complete discussion of hull types.

- **Hull material**

  Examples: Fiberglass, wood, plywood, aluminum

  Note: Student Supplement 1 provides a discussion of the types of hull materials commonly used on outboard-engine boats.

- **Hull shape**

  Examples: Flat-bottom hull, vee hull, catamaran

  Note: Student Supplement 1 discusses the hull shapes commonly used on outboard-engine boats.

- **Hull size**

  Examples: Length, weight, water displacement

- **Power source**

  Examples: Sails, paddles, propeller, fan

- **Engine configuration**

  Examples: Inboard, outboard, stern-drive

- **Engine characteristics**

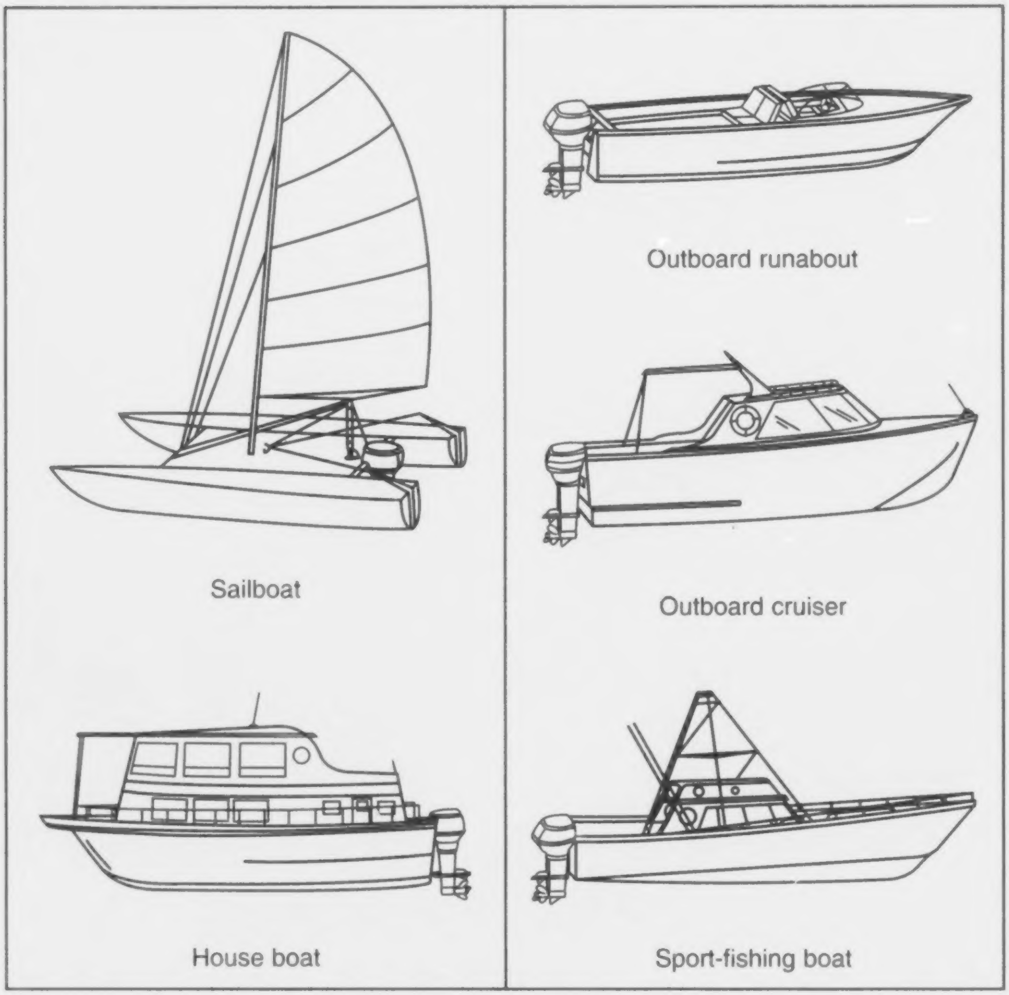
  Examples: Horsepower, number of cylinders, cylinder configuration, type of fuel, type of cooling system

- **Application**

  Note: The term *application* refers to the intended use of a boat. Boats are used as workboats, sailboats, runabouts, cabin cruisers, sport boats, house boats, etc. (See Figure 1 on the next page and Student Supplement 1.)

## Information Sheet

**Figure 1:** Common applications for outboard-engine boats



Sailboat

Outboard runabout

Outboard cruiser

House boat

Sport-fishing boat

2. **Definition of the term *outboard-engine boat system***

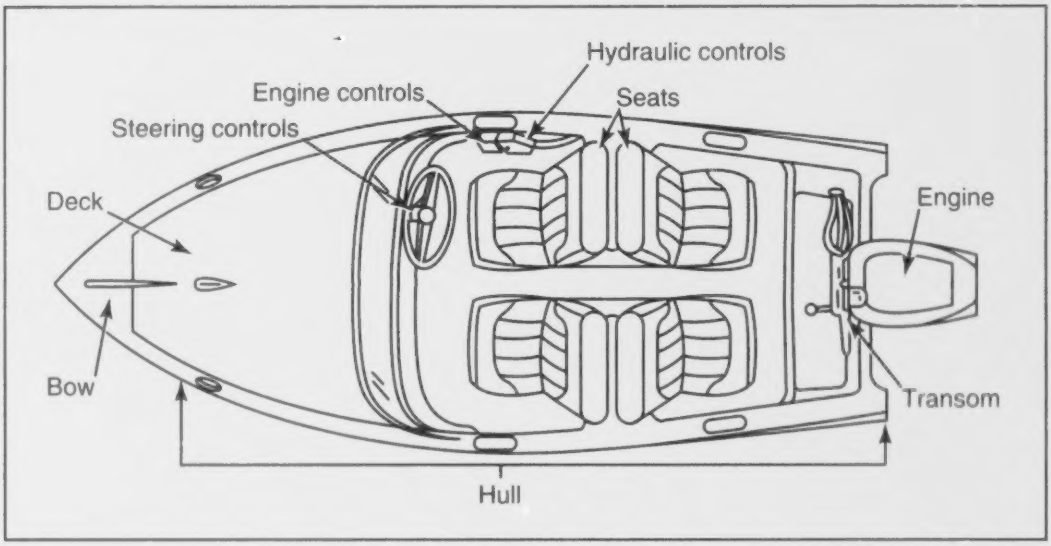
- **Outboard-engine boat system**—System consisting of a boat hull and engine where the engine is normally mounted on the outside of the boat hull (see the illustrations in Figure 1 above and in Figure 2 on the next page)

  Note: This course deals with a type of boat system known as an *outboard-engine boat system*. As you learned in Objective 1, the outboard engine is just one type of engine configuration used in boat systems, and engine configuration is just one way of classifying boat systems. Most of the characteristics used to classify boat systems do not exclude each other. For example, a flat-bottom boat made of fiberglass may use an outboard engine with various characterisitics with regard to horsepower, number of cylinders, etc. The outboard-engine technician must be familiar with all the characteristics used to classify boat systems because the operation of an engine depends on its application.

## Information Sheet

3. **Major components of outboard-engine boat systems and their definitions** (see Figure 2)

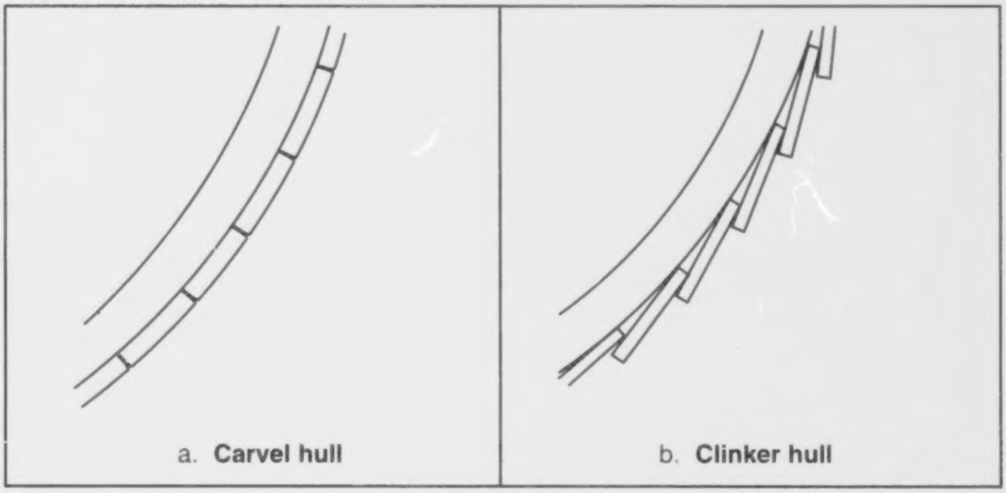
**Figure 2:** Major components of outboard-engine boat systems



- **Engine**—Power source that moves the boat through the water
- **Hull**—Overall structure of the boat that defines its general shape

Note: The hull structure consists of two components: (1) the framework and (2) the skin. Numerous types of framework materials and construction techniques are used to construct the framework, and numerous types of materials are used for the skin. For example, the framework for a wooden hull may be constructed of plywood or wooden planks. If wooden planks are used, they may have flush joints and form what is called a *carvel hull* (see Figure 3-a) or overlapping joints to form what is called a *clinker hull* (see Figure 3-b).

**Figure 3:** Hull structures



a. **Carvel hull**

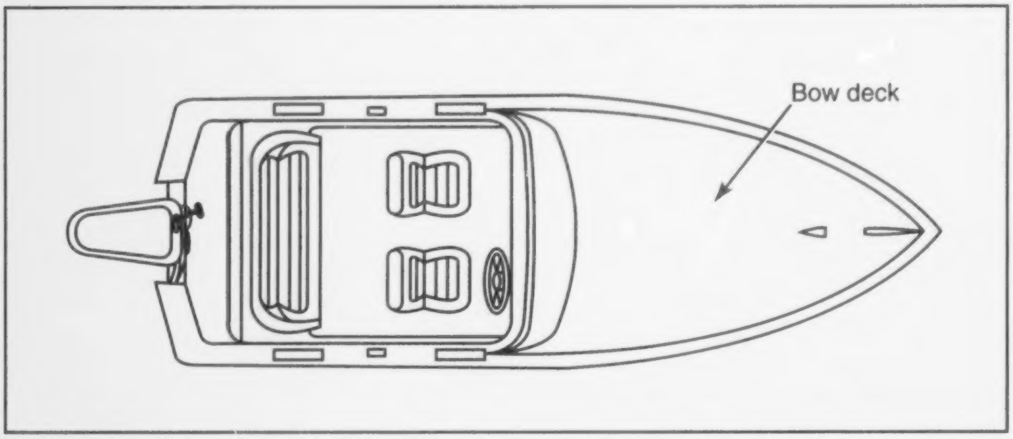
b. **Clinker hull**

## Information Sheet

- **Bow**—Front portion of the hull that cuts through the water as the boat travels forward
- **Deck**—Horizontal surfaces that form the enclosures in the hull

  Note: Small boats seldom have decks. Slightly larger boats may have what is called a *bow deck* (see Figure 4), which covers the front section of the boat to provide reinforcement and to reduce the amount of water that enters the boat. Still larger boats may have an upper and lower section created by a deck that serves as the floor of the upper section and the ceiling of the lower section.

  **Figure 4:** Bow deck



- **Transom**—Rear of the hull that provides a structure for mounting the engine

  Note: Transoms in outboard-engine boat systems are specifically designed to provide a secure and efficient means of mounting the engine. The mounting area may be as simple as a reinforced section with flat surfaces to accommodate the clamps that hold the engine in place, or it may have more-complicated interfaces for electrical and hydraulic systems.

- **Engine controls**—Components that allow the operator to adjust functions such as engine speed, choke-valve setting, and gear ratio

  Note: Engine controls for outboard-engine boat systems may be located on the engine or may be remote from the engine. For example, an outboard engine may have a rope-rewind starter, or it may have an electric starter with a key or pushbutton switch that is located forward of the engine. The engine speed may be set by the operator's adjusting a slide knob on the engine or by moving a throttle lever in a forward section of the boat. Many boats with remote engine-control systems provide a dashboard with gauges, switches, and controls similar to those in an automobile.

- **Hydraulic controls**—Components that allow the operator to raise and lower the engine

  Note: In order to protect the engine during loading, unloading, and trailering and when boating in shallow water with submerged obstacles, most outboard engines are mounted so that the engine can be tilted to raise or lower the normally submerged portion of the engine. The operator may perform this operation manually or with the use of hydraulics.

## Information Sheet

- **Steering controls**—Components that allow the operator to change the direction of boat travel

  Note: In its simplest form in an outboard-engine boat system, steering is accomplished by the operator's using a handle to pivot the engine. More-complex steering systems use cables or hydraulics to make the engine pivot.

- **Seats**—Places for the passengers and operator to sit

- **Accessories**—Components that support the operation of the boat system without being essential to the function or control of the engine and steering system

  Examples: Horn, entertainment equipment, communication equipment, etc.

- **Rigging**—Configuration of the attachments made to a boat

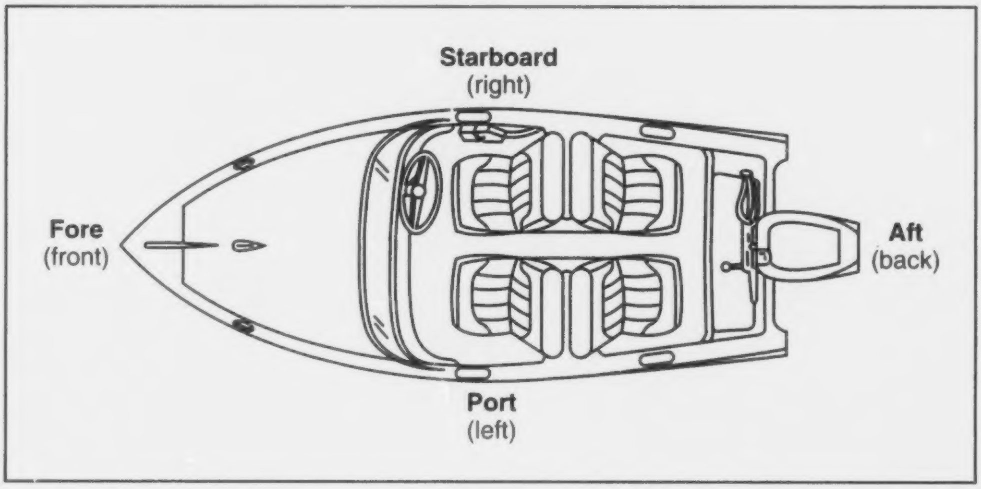
  Note: Originally, the term *rigging* was used to refer to ropes, hardware, and sails of a sailing ship. When applied to outboard-engine boat systems, the term now is used to refer to the mounting of the engine, to the installation of the tie-downs and other hardware, etc.

4. **Directional terms used for boat systems and their definitions** (see Figure 5)

Note: The following terms are relative to the front, back, right, or left of a person facing forward at the midpoint of a boat.

- **Fore**—Front
- **Aft**—Back
- **Starboard**—Right
- **Port**—Left

**Figure 5:** Directional terms



## Information Sheet

### 5. Types of hull conditions and defects and their definitions

Note: Boat conditions affect boat performance. The technicians who service engines are often called upon to provide additional service to other boat systems, including the hull. Technicians must recognize these defects and understand their impact on boat performance even if they are not engaged in the actual repair of such defects. The technician must also realize hull shapes may be intentional, such as a slight hook to reduce rhythmic bouncing.

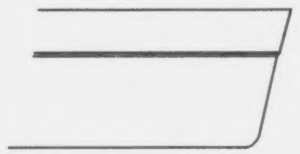
- **Hook**—Condition of the hull in which the center portion of the hull has been bent or has warped above its original contour (see Figure 6-b)

  Note: Also referred to as *hogging*, hooks result from running aground or from weak supporting members that draw up with age or exposure to the elements. This condition may also result from a boat being stored or trailered without adequate support.

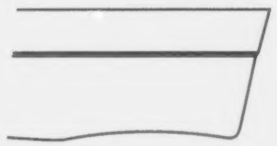
- **Rocker**—Condition of the hull in which the center portion of the hull has bent or warped below its original contour (see Figure 6-c)

  Note: Also referred to as *sagging*, rockers result from swelling or warping of the hull members.

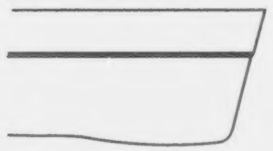
**Figure 6:** Hook and rocker hull conditions



a. **Flat hull**



b. **Hook hull**

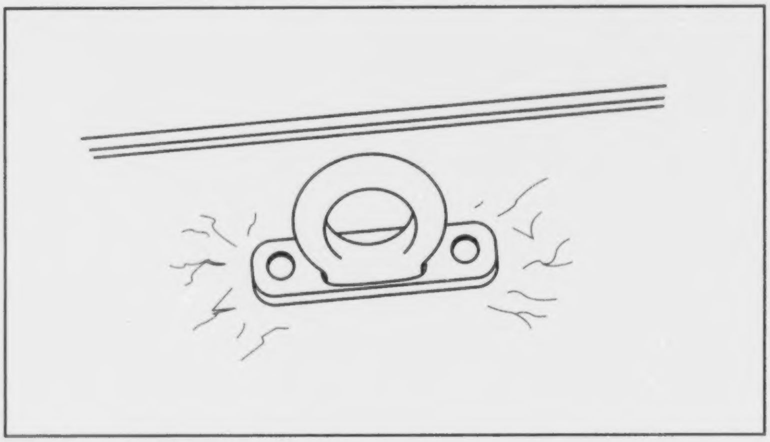


c. **Rocker hull**

## Information Sheet

- **Crazing**—Fine cracks that form in fiberglass hulls and other fiberglass components (see Figure 7)

**Figure 7:** Crazing



- **Fouling**—Deposits on the outside of a boat hull

Note: *Fouling* is a general term for deposits on the surface of a boat hull. Fouling includes barnacles and other marine life, mineral deposits, corrosion, etc.

Barnacles and other marine creatures float about in bodies of water—especially saltwater—in search of a surface to which they can attach. Such surfaces include submerged portions of boat hulls. A hull that is coated with barnacles loses its designed streamlining and increases in weight. These changes affect boat performance.

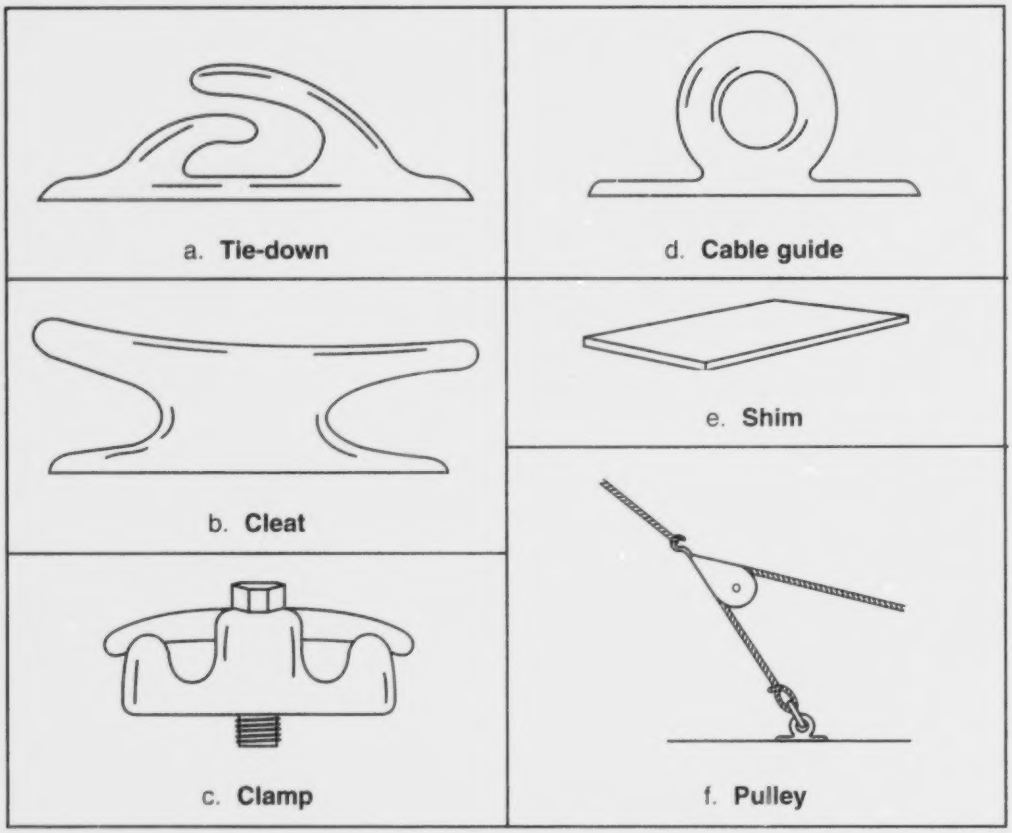
The combining of substances during chemical reactions can lead to the formation of solids or the deterioration of boat surfaces or both. As a general term, *corrosion* is a type of fouling and includes many forms of oxidation, such as rust.

- **Rot**—Decomposition of the hull due to the action of bacteria or fungus

Note: A wet environment promotes the growth of bacteria and fungus. These agents can spread through wood and other materials used in boats. There are two types of rot: (1) dry rot and (2) wet rot. Dry rot is an internal decay that may not be apparent on the outside of wood; wet rot thrives in conditions where the wood is submerged or frequently wet and maintains a wet appearance.

6. **Common types of hardware used with rigging and accessories** (see Figure 8)

**Figure 8:** Common types of hardware



a. **Tie-down**

d. **Cable guide**

b. **Cleat**

e. **Shim**

c. **Clamp**

f. **Pulley**

7. **Common types of instruments and gauges used on outboard-engine boat systems and their purposes**

- **Fuel gauge**—Indicates the amount of fuel in the fuel tank (see Figure 9-a on the next page)
- **Ammeter**—Indicates whether the charging system is providing output (see Figure 9-b on the next page)
- **Engine-temperature gauge**—Indicates the temperature of the engine coolant or an overheat condition
- **Water-pressure gauge**—Indicates the output pressure of the cooling-system pump
- **Speedometer**—Indicates the speed of the boat over the water (see Figure 9-c on the next page)

Note: Measuring the speed of a boat is not like measuring the speed of a land vehicle. Many small boats use a pitot system to indicate approximate speed. The pitot measures the pressure of water on an air chamber within an enclosed tube and provides an electrical current to the speedometer from a transducer.

## Information Sheet

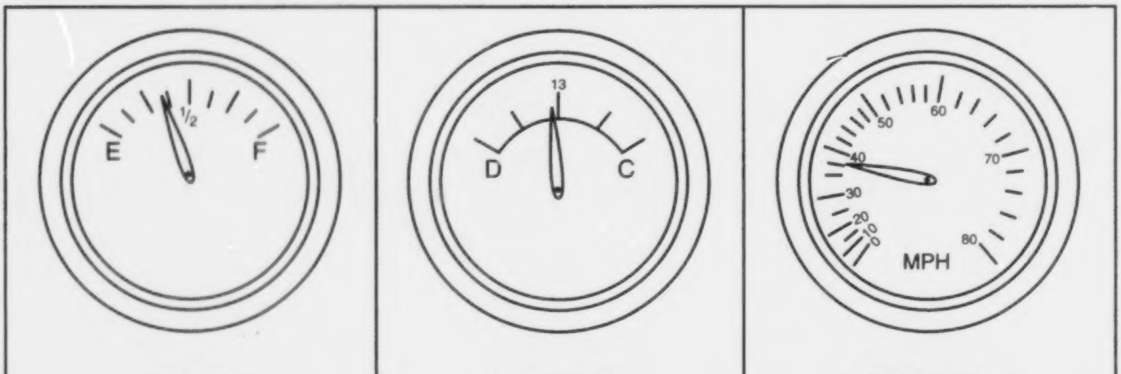
- **Tachometer**—Indicates engine speed (see Figure 9-d)
- **Trim gauge**—Indicates the angle or position of the trim
- **Oil gauge**—Indicates oil pressure or oil-tank level or low oil levels (see Figure 9-e)

  Note: The oil gauge or warning light for a four-stroke-cycle engine generally indicates the oil pressure or provides a warning when oil pressure is low. For two-stroke-cycle engines, oil gauges are generally used only with systems that have remote oil tanks that automatically mix oil with the fuel.

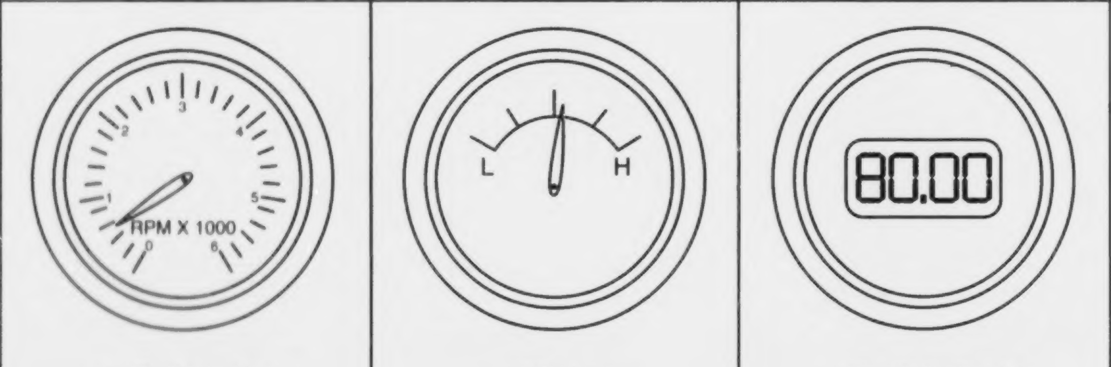
- **Depth indicator**—Indicates underwater features (see Figure 9-f)

  Note: Depth indicators, fish locators, and other devices are used to identify features below the boat. Most of these instruments function by sending sound waves down and measuring the reflection of those sound waves in a simple sonar system. These instruments are useful in measuring the depth of water, identifying underwater obstacles, and locating schools of fish.

**Figure 9:** Types of instruments and gauges



a. **Fuel gauge** b. **Ammeter** c. **Speedometer**



d. **Tachometer** e. **Oil gauge** f. **Depth indicator**

## 8. Common types of electrical accessories used on outboard-engine boat systems and their purposes

Note: Boats with electrical systems often take advantage of this power source to operate electrical accessories. Some of the most popular are described below.

- **Horn**—Warns other boaters of the presence of the boat

- **Bilge pump**—Removes water that has splashed or leaked into the boat

  Note: It is almost impossible to keep water out of a power boat, even if it does not leak. Swimmers, skiers, fish, and equipment bring water into boats. Wakes from other boats, rain, splashing water, and other circumstances cause water to come into the boat. Large amounts of water—called *bilge*—need to be removed because the water increases the weight of the boat, presents slipping dangers, and can cause damage to equipment and instruments. Bilge pumps are used to remove this water, and many bilge pumps in smaller boats are powered by electricity.

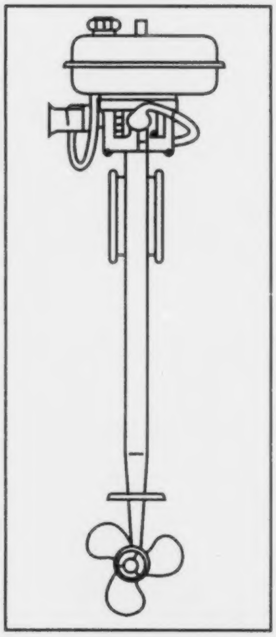
- **Running lights**—Indicate the location and orientation of the boat to other boaters

  Note: Running lights generally are color coded to indicate the fore and aft of the boat and the port and starboard sides of the boat.

- **Trolling motor**—Provides low-speed operation of the boat

  Note: Trolling motors drive the boat at low speeds to allow anglers to search for good fishing locations while trailing lures or bait. A trolling motor may be a small gasoline engine, such as the one shown in Figure 10. Many trolling motors are generally electrically powered and often use a battery separate from that used for other boat electrical systems.

**Figure 10:** Trolling motor



## Information Sheet

- **Entertainment equipment**—Provides audio and video entertainment to boat passengers

  Examples: AM/FM radios, tape players, compact-disc players, televisions

- **Communications equipment**—Provides voice or electronic data exchange between boats or between the boat and land-based facilities

  Examples: Radios, telephones

- **Navigational equipment**—Allows the boat operator to determine the position of the boat and the position of other features relative to the boat

  Note: Radar, geophysical positioning systems using satellites, land-based signal systems, and other types of equipment can be used to determine the position of the boat or can locate other objects, such as land or other boats. Small watercraft—especially those that navigate large bodies of water—often use navigational equipment powered by electricity.

9. **Common types of corrosion-protection systems and their definitions**

Note: When dissimilar metals are brought together in the presence of an acid, a flow of electricity develops. This is the basic principle behind a lead-acid battery, and the process generally occurs with outboard-engine boat systems. The metal of the boat and metal of the engine are often different substances and many bodies of water have dissolved minerals that make them slightly or even highly acidic, especially saltwater. This electrical flow is simply the movement of electrons from one part of the electrical circuit to another. The two poles of the circuit are referred to as the *anode* and the *cathode,* the positive and negative poles, respectively. In an electrolytic circuit, the anode gives up electrons, a process that eventually leads to the breakdown of the material. To prevent damage to the boat and engine, many boat systems are equipped with corrosion-protection systems, such as those described below.

- **Sacrificial anode**—Disposable component that is usually mounted to the engine and is designed to deteriorate more easily than more-important components

  Note: Sacrificial anodes are passive devices—they use no power and simply serve as a source of electrons in the corrosive environment. Often the sacrificial anode will be a trim tab made of aluminum or zinc. Transom tabs and other hardware attachments may also be used as sacrificial anodes.

- **Anodic kit**—Plate mounted to the transom and electrically interconnected to allow electrical flow that deteriorates the plate

- **Galvanic isolator**—Electrical device that is wired into the boat's electrical grounding system to block galvanic flow when a boat is connected to a land-based power source

  Note: The galvanic isolator ensures proper grounding of the electrical system without allowing that system to become part of galvanic flow.

- **Cathode system**—Solid-state controller system that applies battery power to a set of external electrodes to ensure electrical flow to immersed metal requiring protection

  Note: Cathode systems adjust current flow to provide the required level of electrical flow to offset corrosion. The system draws a minimal drain on the battery and has no sacrificial parts.

## Information Sheet

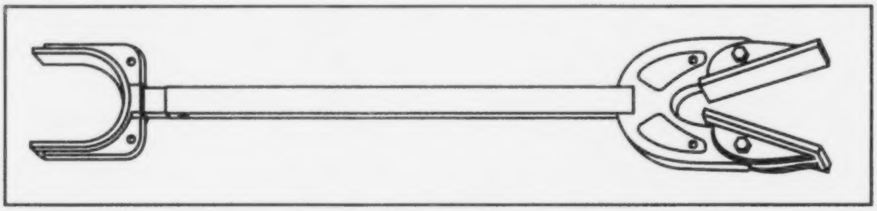
### 10. Common types of hardware accessories used on outboard-engine boat systems and their purposes

Note: Numerous types of hardware equipment can be added to a boat to make it more convenient or safer or to change its performance characteristics. Some of the more-common types are discussed below.

- **Transom savers**—Holds the engine away from the transom during transport and storage (see Figure 11)

  Note: Transom savers are braces that are normally adjustable; they hold the engine away from the transom to keep the engine from bumping the transom and exerting pressure on it during transport.

  **Figure 11:** Transom saver



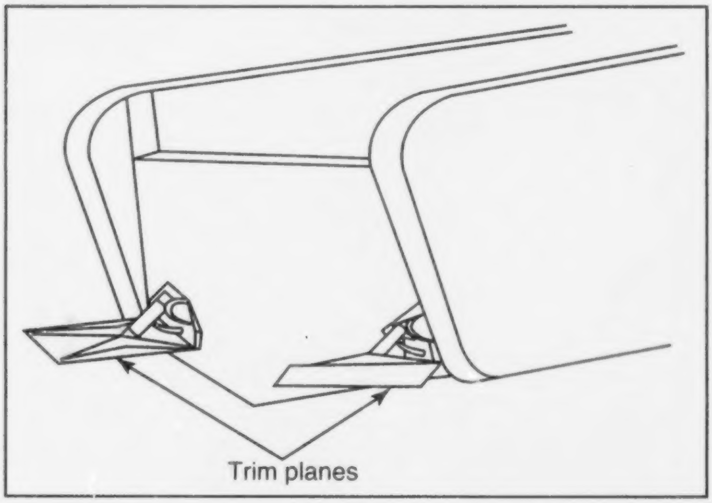
- **Jack plates**—Raise and lower the engine vertically to change the transom height in order to improve acceleration, speed, and fuel economy

  Note: Jack plates are hydraulic controls that are used in conjunction with the trim system to position the engine for optimal operation with changing speeds.

- **Trim planes**—Supplement power trimming of the engine

  Note: Trim planes are plates mounted to the transom in pairs (one on each side of the engine). They are also referred to as *after planes* or *trim tabs.*

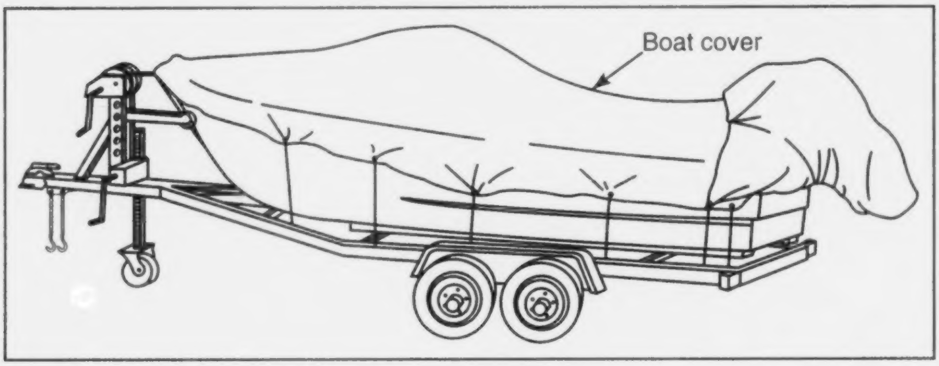
  **Figure 12:** Trim planes



## Information Sheet

- **Boat covers**—Protect the boat from water, sun, and other environmental conditions (see Figure 13)

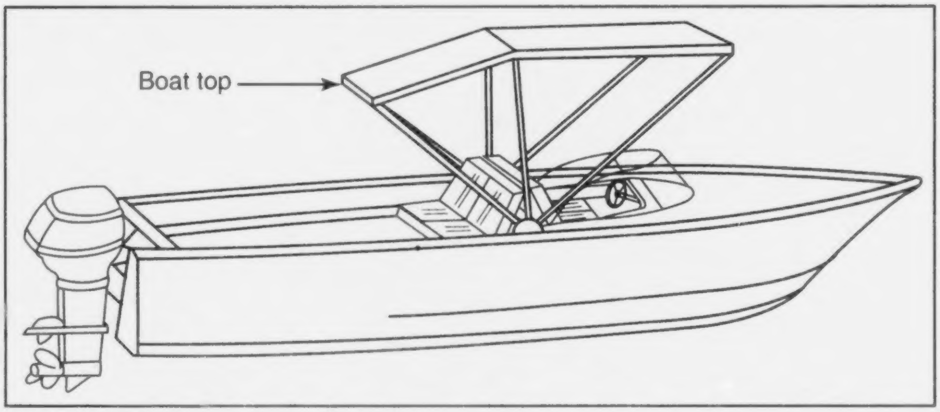
  **Figure 13:** Boat cover



- **Boat tops**—Protect the passenger area of the boat

  Note: Boat tops are basically roofs for the passenger area of the boat. They generally are metal frames that support canvas or fiberglass (see Figure 14).

  **Figure 14:** Boat top



### 11. Typical procedures performed when rigging outboard-engine boat systems

Note: Boat manufacturers produce hulls. These hulls may be completely bare or they may be fully rigged at the factory. Outboard-engine boat systems seldom come from the factory with engines installed. Often this job is done by the local boat dealer. Dealers may install engines on boats to offer complete units or they may allow the customer to select a hull and an engine and then install the engine. Frequently, boat buyers want additional equipment and conveniences added to their boats. While the exact rigging for a boat generally depends on how the boat is to be used and what the customer wants and is willing to pay for, the following are some of the more-common procedures required when rigging a boat.

## Information Sheet

- **Install and adjust outboard engine**

  Note: The engine must be installed and securely mounted to the boat. Most engines come with mounting clamps that will fit most boats. However, in some applications, it may be necessary to replace the standard mounting hardware with some that will fit the boat exactly. Engines are designed for standard mounting heights to ensure that the propeller rides below the surface of the water. To obtain the proper mounting height, it may be necessary to use an extension kit on an engine for specific installations. It may also be necessary to adjust the position of the engine laterally along the transom in order to offset engine torque and obtain a true course.

- **Install and adjust remote engine-control assembly**

  Note: There are four common types of remote engine controls. They include (1) throttle control, (2) shift control, (3) tilt and trim controls, and (4) starting controls. Control assemblies are available that offer all of these functions in an integrated unit, or separate assemblies may be used for each. Often throttle and shift controls are combined, and tilt and trim are frequently included in a single control unit. Remote starting is usually provided as a button or key switch as on a car. Installation of a remote starting system may include the installation of an electric starter on the engine and a battery and charging system. Control assemblies may offer other functions, such as carburetor choking. Remote throttle, shift, and tilt and trim controls commonly use cable linkages that must be properly routed and installed with the proper slack to ensure that a particular movement of the control lever results in the desired amount of adjustment in the engine.

- **Install and adjust remote steering system**

  Note: There are numerous types of remote steering systems. Selection of the proper one will be based on the customer's preferences and the recommendations of the boat manufacturer and steering-system manufacturer. The primary concern is that the system provide easy control for the operator and good response in pivoting the engine. The technician must use a minimal amount of mechanical linkage, such as cabling, and install it so that the engine pivots equally in each direction without binding. The neutral position of the steering wheel or other steering control should provide a straight-line course in calm waters, though the neutral position may be slightly trimmed to offset engine torque.

- **Install tank-to-engine fuel line**

  Note: If the boat is equipped with a remote fuel tank, the fuel line will have to be connected to the engine when it is mounted. Some boats will have a fuel line while others will require that one be installed. Outboard-engine service technicians are often required to install the fuel tank also.

- **Install remote oil tank**

  Note: Because it is inconvenient and messy to mix oil in the fuel of two-stroke-cycle engines, many boat operators prefer to have an oil-injection system that will add oil to the fuel automatically, especially if the engine has an external fuel tank. The tank should be installed in accordance with the manufacturer's instructions and adjusted to ensure delivery of oil at the proper ratio.

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- **Install and service battery**

  Note: As noted above, boat systems equipped with electric starters generally require that the boat provide battery power. Boats that have other electrical equipment, such as communications and navigation equipment, lighting, and entertainment equipment, often have a second battery separate from the starting system that is used to power electrical accessories. If two batteries are used, the boat may include a system for isolating the batteries from each other electrically.

- **Install and adjust pitot system**

  Note: Pitot systems monitor the rate at which water passes through a tube as the boat travels over the water. The principal use of pitot systems in boats is to measure the speed of the boat. The pressure of the water is converted into another energy form, such as using a transducer to drive a speed indicator. The pitot system must be installed so that the induction tube has unobstructed capture of water through which the boat is passing without danger of damage or clogging.

- **Install and adjust transducer system**

  Note: Transducers convert energy from one form to another. For example, a stereo speaker is a transducer that converts electrical energy and often magnetic pulses into mechanical vibrations. Certain instruments and equipment used on boats use transducers to convert mechanical energy into electricity or electricity into mechanical energy. Pitot systems are often tied to transducers to provide an electrical output to instruments such as speedometers.

- **Install and adjust instruments and gauges**

  Note: Boat systems may include many of the same gauges and instruments found on cars, including speedometers, ammeters, oil-pressure indicators, fuel gauges, etc. Additionally, boats are often equipped with special instruments related to navigation, communication, and marine safety. For example, boat instrumentation may include compasses, water-depth indicators, fish locators, anemometers for measuring wind speed, and barometers to measure barometric pressure, just to name a few.

- **Install and adjust electrical accessories**

  Note: Outboard-engine boat systems, especially larger ones, are likely to include a variety of electrical accessories. Houseboats in particular are likely to include a number of electrical conveniences, such as lighting systems, fully equipped kitchens, heating and cooling systems, entertainment centers, water heaters, bilge pumps, and other devices driven by electricity.

- **Inspect boat systems and rigging**

  Note: In addition to being able to rig boat systems, outboard-engine technicians frequently must be able to determine if accessory items are properly installed and operating. As with all devices, boat rigging functions poorly if not properly maintained. Because of the harsh elements and jarring vibrations that boat systems are likely to face, the need to verify proper mounting and installation is just as important as the need to ensure that the equipment operates as intended.

# Orientation to Outboard-Engine Boat Systems and Rigging
# Unit 1

## Student Supplement 1—Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications

### Introduction

The major portion of a boat is called the *hull*. There are many hull designs, with the variations intended to address specific uses for the boat. In the field of marine technology, technicians are likely to encounter numerous hull designs. There are three main ways for classifying hulls. These include (1) the way the hull rides in the water (displacement), (2) the construction of the hull, and (3) the shape of the hull. This supplement describes many of the hull designs commonly used with outboard-engine boats.

### Displacement/ planing

When a solid object floats in water, a portion of the object is usually below the surface of the water. That part of the object displaces water. The object will float as long as the weight of the displaced water is greater than the weight of the object. For an object at rest, the object's weight is the major factor. For a moving object, part of the object's weight is redirected away from the water with its motion. This is the reason that a stone that would normally sink can skip across the surface of a lake. This action of quickly riding over the surface of water is referred to as *planing*.

### Hull type

**Displacement hulls.** These same terms are used to describe how boat hulls are designed to ride in the water. A displacement hull is one in which a large portion of the hull sinks below the surface of the water. In other words, it displaces a large volume of water and, thus, a considerable amount of weight. Displacement hulls are used for boats that move relatively slowly and that are capable of carrying heavy loads. All large ships, including ocean liners and battleships, have displacement hulls. Outboard-engine boat systems that use displacement hulls tend to be slower moving and to be designed to carry more weight, such as barges, tour boats, and houseboats.

**Planing hulls.** Sport boats, race boats, ski boats, and many small fishing boats are designed to travel over the surface of the water quickly during at least a part of their voyage. Such hulls must ride as close to the surface as possible in order to reduce the drag or resistance of the water. In reality, all boat hulls are basically displacement hulls at rest and at low speeds. However, planing hulls are specifically designed so that increased speeds will cause them to ride higher in the water until, in some designs, the boat is actually just skimming the surface of the water.

### Hull material/ construction

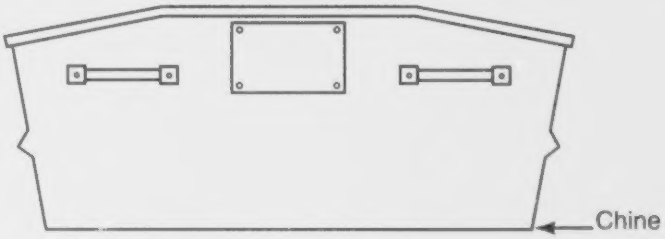
Boat hulls can be made of a number of materials. Those most commonly used for outboard-engine boat systems include (1) metal (usually aluminum), (2) fiberglass, (3) wood for rigid craft, and (4) rubber for inflatable craft. Metal boats generally have what are called *integrated frames*—the metal is shaped or reinforced so that the boat will have adequate strength to hold its shape in normal usage. Fiberglass boats may have integrated frames or a separate frame, such as a canoe with a wooden frame over which fiberglass matting is applied. Wooden boats usually have wooden frames consisting of a central beam or keel along the bottom and ribs rising up from the keel to which the sides of the hull are attached. The two most-common types of wood used for the sides of boat hulls are plywood and wooden planks. When planks are used, they may be installed with the edges flush with each other to form a carvel hull or with an overlap along one edge to form a clinker hull. Carvel hulls are generally easier to work into the curved lines of some hull shapes but may not be as strong or watertight as a well-made clinker hull.

**Hull shape**

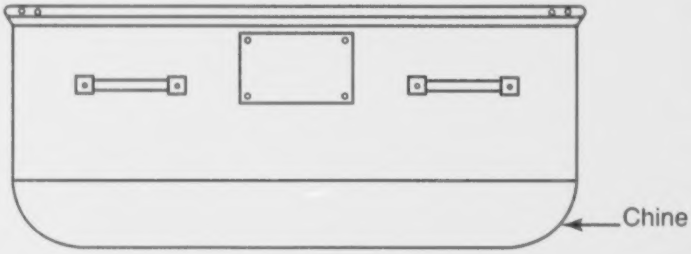
The shape of the hull is primarily determined by its use, including whether the hull is basically a displacement or planing hull. Some of the more-common types are described below.

**Flat-bottom hull.** The bottoms of some boats are essentially level from side to side. Boats with flat-bottom hulls are generally slow and are used for trolling, tour boats, barges, and other boats that do not require rapid travel. The two common designs of flat-bottom hulls are shown in Figure 1: (1) flat-bottom hull with hard chines (see Figure 1-a) and (2) flat-bottom hull with soft chines (Figure 1-b). The two can be distingushed from each other by whether the joint between the sides and bottom—called the *chine*—forms an angle or a curve.

**Figure 1:** Types of flat-bottom hulls



a. **Flat-bottom hull with hard chines**



b. **Flat-bottom hull with soft chines**

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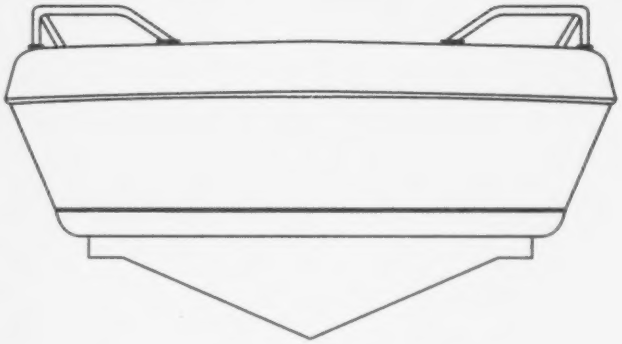
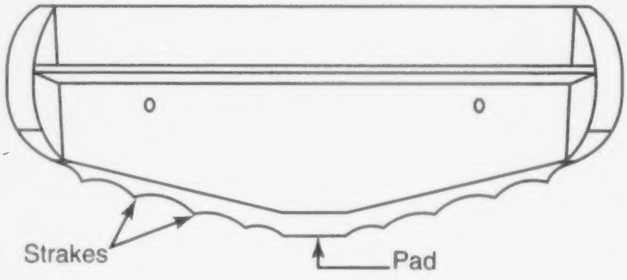
**Vee-bottom hull.** Many boats taper from the chines to the keel to form an angle at the lowest point of the boat (see Figure 2-a). This vee-shape allows the boat to plane as speed increases. Thus, vee-bottom hulls are used for sport boats and ski boats. Vee-bottom hull designs can vary slightly to improve speed or to provide a smoother ride. One method of making the boat ride higher in the water and flatter across the surface is the use of components called *strakes* (see Figure 2-b). Strakes are narrow ridges that run along the length of the hull or part of its length. The increased planing produced by strakes results in harder contact between the boat and the surface of the water and, thus, a rougher ride. To soften the ride while still increasing the degree of planing, boat manufacturers will use different numbers of strakes or will begin the strakes farther back on the hull. This same effect is sometimes achieved by making a portion of the keel area flat to form what is called a *pad* (see Figure 2-b).

**Figure 2:** Types of vee-bottom hulls



a. **Vee-bottom hull**



b. **Vee-bottom hull with pad and strakes**

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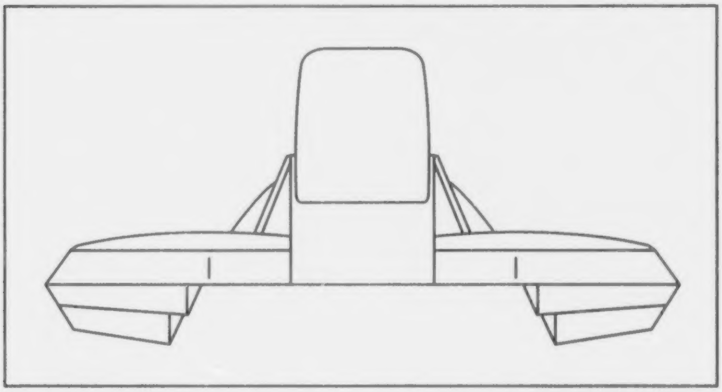
**Tunnel hull.** One objection that boaters have with vee-bottom boats is that they are less stable from side to side than flat-bottom boats, especially as the boat rises from the water at higher speeds. To improve stability, many hull designs increase the amount of hull volume along the chines. But, to keep resistance down, the volume of the center of the hull is reduced. This results in a boat with good stability that can also travel at high speeds.

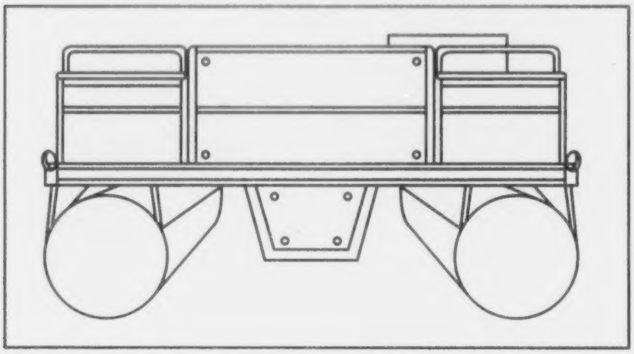
A true tunnel design, such as that shown in Figure 3, is used primarily for racing boats. It may have sharp angles and ridges similar to strakes to assist planing. The fact that the middle portion is hollow makes for a soft ride because the bottom of the boat is not slamming into the water and waves. The enlarged sides of the hull provide stability even in sharp, high-speed turns.

**Figure 3:** Tunnel hull for race boats



**Pontoon.** A similar effect can be accomplished by using pontoons. Pontoons are tanks, generally made of a metal such as aluminum. These metal tanks support the boat deck. In most designs, a pontoon is installed along each outside edge of the boat. The pontoons provide good stability and reduced resistance because of the open space between them. While stability is the major effect of the pontoons, planing of the pontoon hull can be improved by streamlining the noses of the pontoons. Pontoon boats offer a flat, highly usable deck, suitable for houseboats.

**Figure 4:** Pontoon boat



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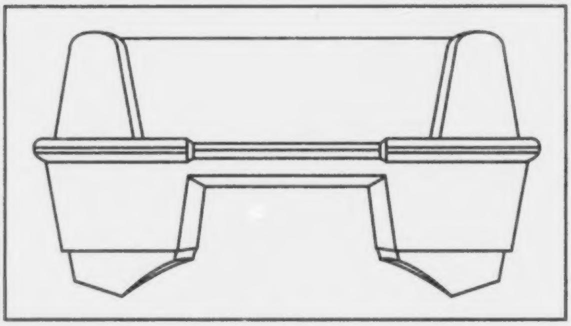
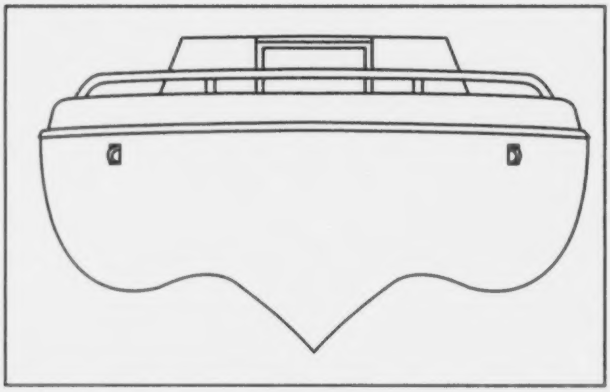
**Catamaran.** A catamaran is similar to a pontoon design except that the hull generally provides the deck, tunnel opening, and buoyant bodies in an integrated hull (see Figure 5). Catamarans are often equipped with sails, even those with outboard engines. They are best suited for lower-speed cruising.

**Figure 5:** Catamaran



**Cathedral hull.** The cathedral hull, or tri-hull, tries to capture the advantages of both vee-bottom hulls and the improved stability of tunnel designs. These designs generally have a vee-bottom keel but are enlarged along the chines. While this design provides good stability, less speed is attainable and the ride can be rough in choppy water. The cathedral hull is most often used for larger cruisers and family fishing boats, though some ski boats use the design.

**Figure 6:** Cathedral hull



**Applications**

The intended use of a boat will affect the choice of hull, of engine, and of how the boat is rigged. For example, an outboard-engine boat system that is intended primarily to be used for deep-sea fishing is likely to have a larger displacement-type hull in order to accommodate passengers and equipment and to perform better in rough seas. The boat will use one or more engines to provide horsepower in excess of 75 horsepower and be equipped with low-pitch propellers (11 to 13 inches). The deep-sea fishing boat will be rigged with chairs, tie-downs, rod-holders, canopies, etc., that will make fishing more convenient and comfortable. It will have communications, navigation, and safety equipment to support venturing far out from shore in potentially rough waters.

The table in Figure 7 lists some of the more-common outboard-engine boat applications and the types of hulls, engines, propellers, and special rigging that may be included on outboard-engine boat systems configured for that use.

**Figure 7:** Common outboard-engine boat applications

| Boat type/application | Hull design | Engine hp | Propeller pitch/ aluminum stainless steel | Special rigging |
|---|---|---|---|---|
| **Workboats**—Boats used for basic transportation and fishing | Flat-bottom inflatable, wood, or aluminum, often with slightly exposed keel | Less than 30 | 11-13<br>Not generally used | Basic seats, swivel seats, transom savers, oar locks |
| **Sailboats**—Boats with sails and engines for harbor cruising and windless conditions | Displacement with large keel or catamaran in wood or fiberglass | 4-25 | 11-13, often with high reverse thrust<br>Not generally used | Rigging for mast and sails, rudders, center-offset engine-mounting hardware |
| **Runabouts**—Boats used for faster transportation, fishing | Vee-bottom, usually fiberglass | 40-70 | 12-19<br>12-16 | Padded seats, swivel seats, external fuel tanks, steering |
| **Recreational boats**—Ski boats, cruisers up to 19 feet in length, fishing boats | Fiberglass or wood vee-bottom, cathedral hulls, some aluminum pontoon hulls | 40-115 | 17-21<br>16-22 | Ski rigging, seats, instrumentation, external fuel tanks, steering |
| **Barges**—Tour boats, transports | Flat-bottom or pontoon, wood or aluminum | 75-115 | 11, 13<br>10, 12 | Canopies, tie-downs |
| **Cabin cruisers**—Boats used for longer trips, deep-sea fishing | Fiberglass or wood vee-bottom or cathedral 19-27 ft | 75-115 | 13, 15<br>14, 16 | Virtually any convenience or comfort feature |
| **Sport boats**—Boats used for racing, faster transportation | Fiberglass high-planing vee-bottom or tunnel bottom | 60-115 | 23 and higher<br>24 and higher | External fuel tank, steering and controls, instrumentation |
| **Houseboats**—Boats used as residences and for frequent overnight stays | Flat or shallow vee-bottom in wood or fiberglass or aluminum pontoons | 60-115 | 11-15<br>12-16 | Virtually any convenience or comfort feature |

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Student Supplement 2—Guidelines for Rigging Outboard-Engine Boat Systems

**Introduction**

All of the accessories that can be added to a boat hull, including the outboard engine, make up what is called the *rigging*. These include the equipment used for starting, controlling, steering, and monitoring the engine; the equipment used for providing for the passengers' comfort and safety; the equipment used for communicating with others; the equipment used for navigating the boat; and the equipment used for equipping the boat for specific uses, such as skiing or fishing. This supplement discusses some of the general guidelines for rigging a boat and some specific guidelines about certain equipment. It is important that the technician understand and follow these guidelines because rigging a boat system carries liabilities with it. An improperly installed component may not operate correctly. Furthermore, a component that is not properly rigged may damage the boat or even endanger its passengers.

**General guidelines**

**Hardware selection.** A variety of hardware is used to accommodate boat accessories. These differences are necessary due to the varying purposes of the hardware and the types of accessories that can be installed. For example, hardware may be used to fasten a component permanently or to fasten it so that quick removal is possible. The hardware may hold the component in place or allow it some freedom of movement. The two most-important considerations beyond ensuring that the hardware serves the correct purpose is to use the correct-sized hardware and to use hardware designed to survive a marine environment. For instance, a cable guide must be able to provide a secure installation so that it will remain in place despite the vibration of boat operation and the stresses exerted by the movement of the cable. It must provide an inside diameter that allows the cable to move easily, but it must also have a diameter small enough that the guide does not take up excessive space or allow the cable to kink. If the guide is susceptible to corrosion, it may become weak and brittle or deposits on its surface may restrict cable movement.

Metal hardware should be stainless steel or provide some other resistance to the high humidity and corrosive forces of the marine environment. Hoses and lines should resist deterioration in the marine environment and when exposed to the materials that they will handle. The manufacturer's packaging will indicate approval for use with fuels, high pressures, etc. Also, ensure that the materials accommodate the required capacities. The manufacturer will generally supply or specify hose diameter, wire gauges, cable strengths, and other capacity limitations. Manufacturers often include proper hardware with their installation kits. Of particular concern is that fasteners meet strength requirements, such as hardware grades.

**Secure mounting.** The technician must provide secure mounting when securing accessories to a boat. There are three aspects to this. First, there must be adequate mounting hardware. That means that the number of screws, bolts, and other securing hardware and the strength of those devices must hold the accessory in place during operation of the boat. Second, the securing hardware must be properly tightened or latched. This includes the installation of pins, locking nuts or additives, and other safeguards. Third, the technician should ensure that the installation site provides a good base for securing the accessories. This is especially true of fiberglass hulls. It may be necessary to install reinforcement such as wooden blocks or metal plates to spread the stress over a larger area to prevent crazing and cracking of the fiberglass.

**Proper installation.** Most equipment will come with installation instructions and often required hardware. The technician should ensure that the equipment is suitable for its intended use, and he or she should install the equipment in accordance with the manufacturer's directions.

### Guidelines for selecting and installing engines

- Match the engine to the boat and to the intended use of the boat.

  The engine should be of the proper horsepower, rpm rating, height, and propeller configuration for the size, weight, and intended use of the boat.

- Determine the required mounting height and whether an extension kit is required.

  Boats are generally designed so that at their top speed the antiventilation plate is even with the surface of the water.

- Determine the mounting hardware required.

  Most outboard engines are equipped with mounting brackets that clamp onto standard transoms. In some cases, the technician may have to obtain a different size of clamp to accommodate special transoms.

- Determine the impact of installation of related systems such as steering systems, tilt and trim systems, etc.

  There are a number of related systems that may be connected to the engine, and such systems may affect the installation of the engine. For example, if the engine uses a hydraulic-tilt system, a different transom mount may be required.

- Use only manufacturer-approved mounting hardware and procedures.

  Do not make unauthorized modifications to the boat or engine to accommodate your installation. Do not use hardware that does not meet the installation specifications. For example, if hardened bolts are required, do not use standard bolts.

- Ensure that the engine is properly positioned laterally along the transom.

  Normally, an engine is centered on the transom. However, in some installations, the engine may be offset to one side or the other to overcome engine torque.

### Guidelines for installing engine-control assemblies

Sitting at the rear of the boat and using the tiller arm to control the engine is not always the most convenient method of operating a boat. Many boat operators prefer that the boat be configured more like a car, allowing the operator to sit in a forward position and controlling the engine remotely. There are five primary functions that are controlled from this position: (1) starting the engine, (2) adjusting the flow of fuel to the engine (throttle control), (3) shifting the engine between forward and reverse, (4) tilting the engine, and (5) adjusting engine trim. The following covers the guidelines for installing these control assemblies.

**Remote starters.** Generally, remote starting is done with an electrical circuit similar to an automotive system. An electric motor is installed on the engine so that it engages the flywheel when the motor is running. Many engines come from the factory with the starter motor installed, often with a starter button on the tiller handle. In other cases, the technician will have to install the starter motor. If the technician must install the starter, the following considerations are most important.

- Select a starter that is specifically recommended for that engine.
- Follow the directions of the engine manufacturer and the starter-motor manufacturer for completing the installation.
- Ensure that the starter motor is securely mounted.
- Ensure that the starter motor is properly grounded. Provisions must be made to connect the starter motor electrically to the power source's ground field either through the engine ground system or through a separate connection.
- Ensure that the starter motor is not shorted. If a starter motor is grounded through its housing, it is easy to bring the housing into contact with the hot side of the circuit.
- If a second battery is used for other electrical functions, ensure that the two electrical systems are isolated from each other.

Remote control of the starter motor is generally provided by a button or a keyswitch located on the dash. Again, installation of the switch should be done in accordance with the manufacturer's instructions. Generally, the boat owner will be able to choose the type of switch to be installed and its location. The owner's preferences should be honored unless there is some safety or operational conflict.

Many starter switches are mounted to or through the dash panel. The technician should strive to make the installation attractive. Often the installation will require drilling one or more holes in the dash panel. The installation instructions may include a template to assist with the locating of those holes along with recommended drill-bit sizes.

The wiring for the system must be the correct gauge. The wiring should be routed in such a way that it does not present a tripping hazard or interfere with the operation of other systems while also avoiding the potential for shorting.

Some starter-system switches will include safety lanyards. The technician must ensure that lanyard operation is functional. For example, the starter switch cannot be located in a position that is outside the comfortable range of the lanyard or placed where the lanyard cord will interfere with the operation of other systems, such as the steering system.

**Throttle control.** Most throttle controls are lever-operated devices mounted to the right of the boat operator. They generally use cables routed to a control rod or lever on the engine and operate like throttle levers on lawn mowers. The primary concerns in proper installation are that the cable is the correct length for the installation and that it will operate without binding. Most throttle-control-system cables will consist of a metal sheath with a stiff wire that moves within the sheath. The required length is one in which the cable can be routed out of the way with a minimum length and number of bends. Where bends are necessary, they will have a minimum radius as recommended by the manufacturer. Cable-bend radius refers to how sharply the cable is bent. If a cable bend is thought of as a portion of a circle, bend radius is the distance from the cable to the center of that circle. The greater the length of the radius, the less likely it is that the wire will bind inside the sheath.

Another factor in throttle-control selection is that the travel distance of the control lever is adequate to cause the carburetor throttle to travel over its full range. Otherwise, the engine will not be able to reach its full rpm or will not idle down to its lowest speed.

Throttle-control assemblies may be integrated with other controls such as choke controls or even tilt and trim controls. The technician must ensure that the installation of an integrated control assembly allows the proper operation of each function.

**Tilt, trim, and shift.** Available as separate or integrated control assemblies, these systems allow remote operation of their related functions. All three are available with mechanical or electrical linkages. Additionally, the tilt and trim functions may use hydraulic actuation. Consequently, the technician must ensure that the interfaces between these power-transfer linkages operate properly.

Concerns for mechanical and electrical installations are the same as those described above for starting and throttle systems. For hydraulic control of tilt and trim, the hydraulic components are generally built into the engine design, and the technician is basically responsible for ensuring that those components can be correctly controlled by the linkage from the control assembly.

## Guidelines for selecting and installing steering systems

A common task for outboard-engine technicians is the installation of a steering system in medium-sized boats as an upgrade of the boat's capabilities. Additionally, technicians are called upon to service existing systems, which may include the replacement of parts. These procedures normally involve cable systems, and the guidelines provided here address such systems. Hydraulic-system installation and maintenance must be done in strict adherence to the system manufacturer's instructions. The guidelines on the next page apply to throttle and shift cables as well.

## Student Supplement 2

- Match the steering system to the boat.

  The suitability of a steering system depends on a number of factors, including the hull design and size, the size of the engine, the number of engines, the way the boat is operated, whether power assist is going to be used, etc. The goal is to provide a steering system that is physically capable of providing effective, responsive steering across the full range of speeds and maneuvers that the boat will be expected to achieve in a way that allows the operator to control the boat safely, confidently, and comfortably.

- Match the steering system to the operator's preferences.

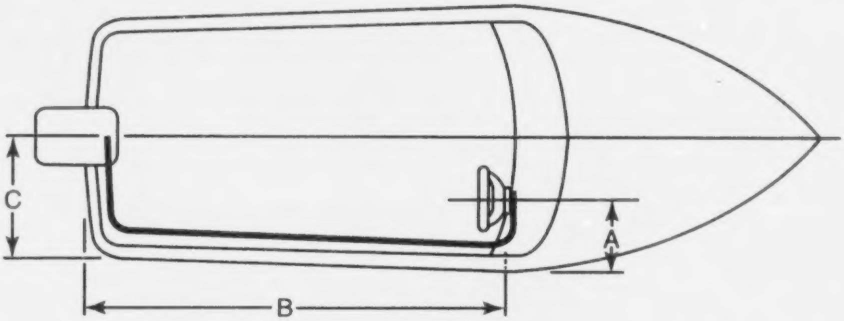
  Is the boat to be steered while the operator is standing or seated? How tight a steering system does the operator want? Does the operator prefer the steering wheel to be vertical or at an angle? The answers to these and other questions affect the installation. For example, the tightness of a steering system relates to how many turns of the steering wheel it takes to turn the engine from a full-left to a full-right position or vice versa. A typical system may require 2.5, 3, or 3.5 turns for a full range of engine swivel. A greater number of turns means less effort is required but more turns are needed to achieve the same engine pivot. The positioning of the steering wheel must also be considered. Typical marine systems are designed so that the wheel is parallel to the dash or tilted at an angle of approximately 20 degrees to the dash.

- Plan the cable routing to be as direct as possible (see Figure 1 on the next page).

  Force is lost over the distance of the cable. The longer the cable, the greater the loss of force. Further, cable with excessive slack is more likely to have backlash. Finally, the extra cable is a waste of space, money, and installation time.

## Student Supplement 2

**Figure 1:** How to measure for new steering-cable installations



A = Distance from the center line of the wheel to the gunwale.
+B = Distance from the dash to the transom.
+C = Distance from the gunwale to the center line of the transom or engine tilt tube.

Total = Basic measurement

The total of A+B+C is your basic measurement. From that total, deduct 4 inches for every 90-degree bend in the cable. For installations that are mounted to the transom or splashwell, deduct 6 inches. For installations through the engine tilt tube, add 6 inches. Then, round the final total up to the next whole foot.

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- Keep the number of bends to a minimum.

  Each bend reduces the efficiency of force transmission and introduces an opportunity for backlash. The total bends in a cable should never exceed 360 degrees. For example, in a typical installation where the cable runs from the steering column to the side of the hull, along the hull to the transom, and along the transom to the engine, two 90-degree turns are required, for a total of 180 degrees. If the technician were to run the cable to the floor of the hull, to the side, to the transom, and up to the engine, two more 90-degree bends would be introduced. This brings the number of bends to four and the total amount of turns to 360 degrees; further, this approach uses considerably more cable.

- Allow the largest bend radii practical.

  The angle of the bend is not the only consideration in changing the direction of cable routing. How sharply the turn is made also affects the installation and efficiency of the cable. This aspect of cable routing is referred to as *bend radius*. The term applies to a hypothetical circle that could be drawn using the curve of the cable turn as a segment of the circle. The radius is the distance between the cable and the center of that circle. The longer the radius, the more gradual is the curve of the bend. A longer bend radius improves the force-transmission efficiency of the bend. However, long radii take up more space, so a practical compromise must be achieved in each case.

- Use a cable of the proper length.

  A technician may choose to order extra length in a cable to allow for mistakes in measuring or other problems. However, every extra inch of cable decreases the efficiency of the cable, while a cable that is too short may reach the engine but not allow full movement in pivoting or may stress the system components. A typical method recommended by cable manufacturers is to measure the distance of the routing, deduct an amount for each bend, adjust the length for the method of connecting the cable to the engine, and then round that distance up to the next whole foot to determine the total cable length.

- Use only approved cable.

  Steering cable is specifically designed for use in marine applications. The output ends are anticorrosive stainless steel, while the outer jacket is a special plastic compound that resists deterioration from the sun, rain, and other elements.

- Straighten the cable prior to installation.

  The new cable should be removed from its carton and unwound onto a clean, dry, level surface. The technician should then gently shake the cable to remove any remaining kinks and check the cable by hand, feeling for kinks along the length of the cable. Cable that is excessively kinked or damaged should not be installed.

- Use care not to step on the cable or subject it to unnecessary bending and stresses.

  Excessive pressure can permanently deform a cable or damage the jacket so that the cable does not move easily inside the jacket. The technician must be careful not to step on the cable, drop heavy objects on it, place it in a bind, drag it over sharp surfaces, or otherwise damage it.

- Use ties or hangers to secure the cable every 6 feet (2 meters).

  If the cable is not secured along its length, the friction between the cable and its jacket tends to make the cable assembly bend rather than move the free end. Additionally, unsecured cable can become damaged or present hazards to boat passengers.

- Lubricate the cable and installation as recommended.

  Internal lubrication of the cable is not required. However, the cable or steering-system manufacturer may recommend lubricating the steering gear or other components.

## Student Supplement 2

### Guidelines for selecting and installing tank-to-engine line

External fuel tanks for outboard engines are classed as (1) permanent or (2) portable. A permanent tank is attached to the hull, while a portable tank is connected to the engine temporarily and can be removed without much effort. A typical portable system is illustrated in Figure 2 on the next page with components labeled.

- Hose, lines, and connectors should be certified for use with fuel.

  Not all lines and hoses are rated for carrying fuel. Those lines and hoses that are approved for fuels will be labeled to indicate the types of fuels for which they can be used. This labeling is usually placed on the packaging and often on the hose itself.

- The tank must be located so that it will be adequately ventilated.

  Ventilation may be natural-draft ventilation or forced-air ventilation and should be adequate to ensure that fumes do not accumulate.

- If a quick-disconnect line is installed, it must provide an automatic-shutoff capability.

  Avoid spilling fuel when working with fuel systems. The connections that are routinely removed should have a means of shutting off fuel (automatic-shutoff capability) to reduce the amount of fuel that the lines contain.

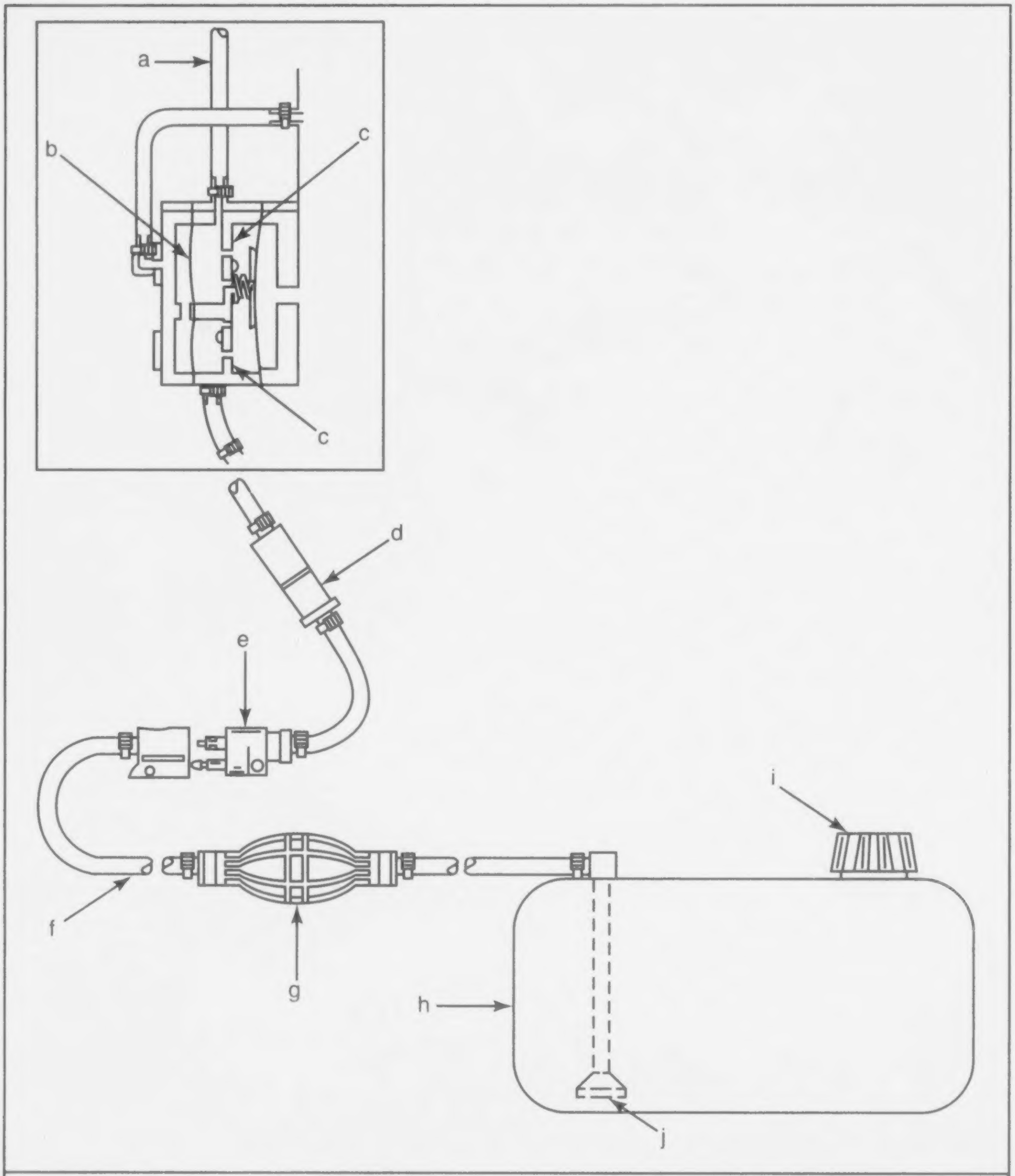
- The hose diameter and length must comply with installation requirements.

  Many fuel systems will specify a hose diameter based on the distance between the tank and fuel pump.

- If an anti-siphon valve is installed, it must have adequate capacity to match the engine horsepower.

## Student Supplement 2

**Figure 2:** Portable external fuel tank



a - Fuel-pump outlet to carburetor
b - Diaphragm
c - Check valve
d - Fuel filter
e - Fuel connector
f - Fuel line
g - Primer bulb
h - Fuel tank
i - Fill cap
j - Fuel pick-up

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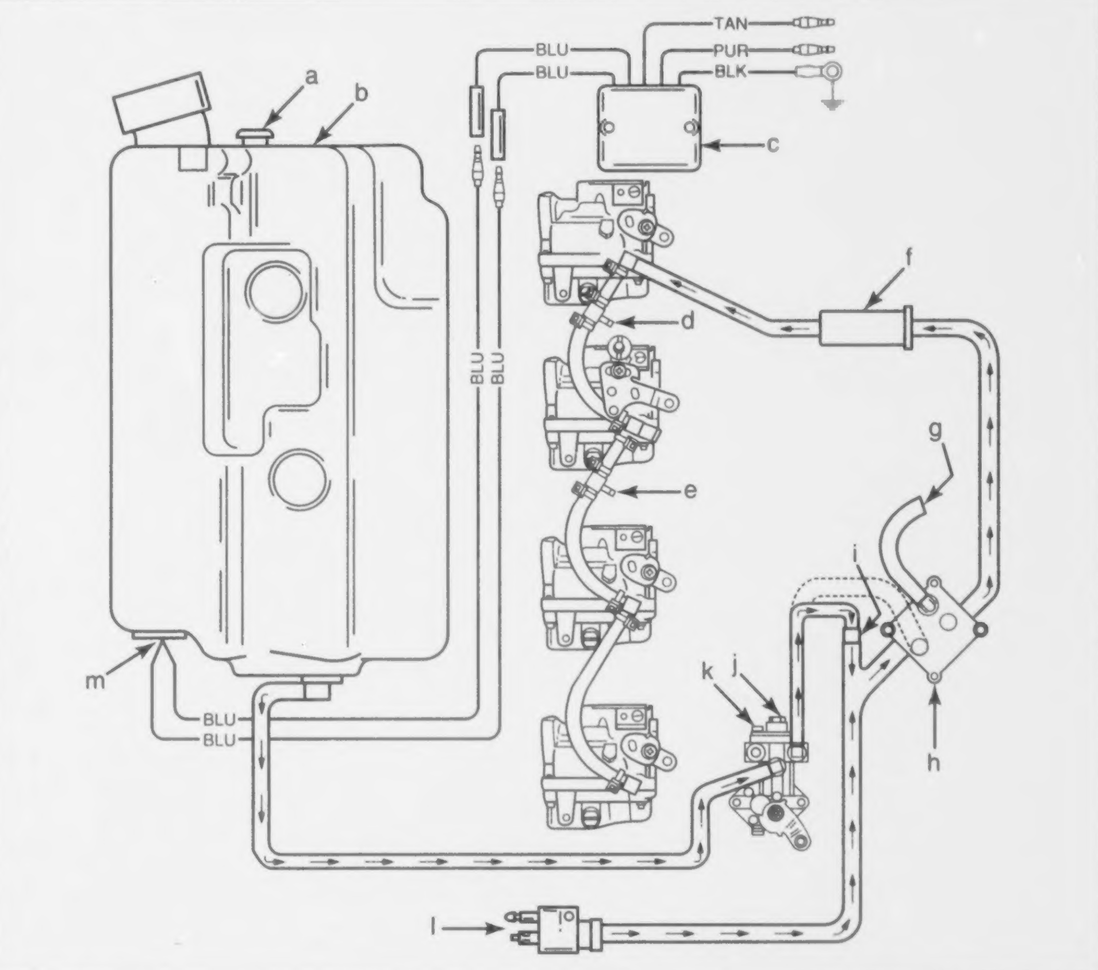
## Student Supplement 2

**Guidelines for installing remote oil tanks**

There are two types of remote-oil-tank installations: (1) those that use separate oil and fuel pumps, as in Figure 3, and (2) those that use a single pump for both fuel and oil. Other components in the system include connecting lines and pressure warning systems. Figure 3 below shows a four-cylinder system. Note that separate oil and fuel pumps are used.

- Install a check valve at the connection of the fuel system to prevent fuel from entering the oil lines.
- Ensure that the line diameter is that recommended by the manufacturer to allow sufficient oil flow to provide the proper oil/fuel ratio.

**Figure 3:** Four-cylinder system



a - Oil-tank vent
b - Oil tank
c - Low-oil/overheat-warning module
d - Fuel-enrichment-valve fuel fitting
e - Accelerator-pump fitting (4-cylinder models only)
f - Fuel filter
g - To crankcase pulse fitting
h - Fuel pump
i - 2-psi check valve
j - Oil-pump bleed valve
k - Oil pump
l - Fuel-inlet fitting
m - Low-oil sensor

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## Student Supplement 2

### Guidelines for installing batteries

Batteries are used on boats to power electric starter motors and other electrical accessories. Often, a boat with a number of electrical accessories will have more than one battery system. These systems frequently share the same charging system but are otherwise electrically isolated from each other.

The following guidelines apply to the handling and installation of batteries.

- Be sure that the selected battery is rated for marine use. Marine batteries are generally labeled as such by the manufacturer and are specifically designed for operation in the corrosive atmosphere of the marine environment.

  Note: Many marine batteries are not rated in the same way as automotive batteries. For example, the cold-cranking amperage of marine batteries is based on a temperature of 0°F while automotive batteries are rated at 32°F.

- Ensure that the battery is rated to handle the systems that will be powered by it. The battery should have adequate amperage and voltage to power the intended systems and be capable of recharging at a fast enough rate to maintain adequate storage capacity. This may require that the technician examine the power requirements of the systems to be powered and compare those to the battery capacities defined by the battery manufacturer.
- Ensure that electrical circuits are adequately protected with fuses or circuit breakers, including proper grounding through the battery circuit.
- Wear eye protection and protective clothing, including rubber gloves and apron, when servicing batteries.
- Ensure that the installation site is protected so that people and objects are not likely to come into contact with the battery terminals, which can cause arcing.
- Ensure that the battery is secure so that it will not tip over and spill electrolyte.
- Ensure that the installation site is vented. Recharging batteries can give off explosive fumes. The installation site must be vented so that those fumes do not get trapped inside the battery compartment.
- Do not smoke around batteries, especially when they are charging.
- Wash your hands thoroughly after handling batteries.
- Dispose of discarded batteries properly.

### Guidelines for installing pitot systems and transducers

Land-based systems have drive wheels that allow the speed of the vehicle to be measured based on the rate the wheels are turning. However, boats do not have that ability. While it is possible to measure engine rpm with a tachometer, engine speed is not a reliable indication of how fast a boat is traveling because water current, wind, and loads (such as a number of passengers or skiers) can affect the number of rpm's required to maintain a desired engine speed. Thus, another method is required to measure boat speeds. Many boats use a *pitot* (pronounced *pee-toh*) system; these devices use a tube with a small opening in it that allows water to pass through it. The moving water possesses mechanical energy that can then be used to power mechanical devices or converted to another form of energy to power other types of devices. A common configuration is to convert the mechanical energy of the pitot system into electrical energy with a device called a *transducer.* This electrical energy is then available to power devices such as speedometers that provide the boat operator with an indication of the speed at which the boat is traveling.

It is beyond the scope of this course to discuss the many designs of pitot systems and transducers. However, all such systems have some common installation principles, as outlined below.

- Follow the manufacturer's instructions for installation.
- Ensure that pitot tubes are positioned so that they will capture water flow, as prescribed by the manufacturer.
- Ensure that the pitot tube is not likely to be damaged or obstructed at the installation site.
- Use care when handling pitot tubes as they are fragile and cannot be repaired if damaged.
- Ensure that the components of the system—pitot, transducer, and instruments—are suited to the application. For example, the system must track speeds over the operating range of the boat. It will do no good to install a system that has a range of 0 to 40 knots if the boat is to be operated at 80 knots.
- Ensure that the pitot and transducer are suited to each other and to the type of display to be used. For example, some transducers are suited for digital displays, while others are not. Follow the speedometer manufacturer's recommendations for a data-input system.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Assignment Sheet 1—Determine Specifications for Selecting and Installing Outboard Engines

Name ______________________________ Date ______________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

**Introduction** An engine must be properly matched to the boat and its intended use. This includes selecting the proper horsepower of engine and related features with regard to whether the engine will use electric starting, remote steering and control, etc. The engine must be installed at the proper height. Outboard engines have standard heights, so basically the selection of the engine includes identifying the height that will allow the propeller to extend the proper distance into the water. The engine must also be equipped with a propeller appropriate to the boat's intended use. This assignment sheet will provide you with practice in matching engines to specific boats and their intended uses.

**Exercise**

**Directions** Read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems." Next, have your instructor complete the first three items in each section of this assignment sheet. Then, using the resources available in your facility, determine the answers to questions 1 through 7 in each "Technician-provided information" section. Write your answers on the blanks provided with each question.

## Assignment Sheet 1

**Part A** **Boat system 1**

Instructor-provided information

1. Make and model of boat — ______________________

______________________________

2. Length of boat — ______________________

______________________________

3. Intended use of boat — ______________________

______________________________

______________________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model — ______________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ______________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ______________________

   ______________________________

   ______________________________

6. How will the engine be positioned on the transom?

   Engine position — ______________________

   ______________________________

   ______________________________

7. What propeller should be used with this engine and boat application?

   Propeller — ______________________

## Assignment Sheet 1

**Part B** **Boat system 2**

Instructor-provided information

1. Make and model of boat — ______________________
2. Length of boat — ______________________
3. Intended use of boat — ______________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model — ______________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ______________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ______________________

6. How will the engine be positioned on the transom?

   Engine position — ______________________

7. What propeller should be used with this engine and boat application?

   Propeller — ______________________

## Assignment Sheet 1

**Part C** **Boat system 3**

Instructor-provided information

1. Make and model of boat — ______________________________

______________________________

2. Length of boat — ______________________________

______________________________

3. Intended use of boat — ______________________________

______________________________

______________________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

Engine make and model — ______________________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

Yes No

3. What is the correct mounting height for the engine selected?

Mounting height — ______________________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

Yes No

5. What mounting hardware will be required for the engine installation?

Mounting hardware — ______________________________

______________________________

______________________________

6. How will the engine be positioned on the transom?

Engine position — ______________________________

______________________________

______________________________

7. What propeller should be used with this engine and boat application?

Propeller — ______________________________

## Assignment Sheet 1

**Part D** **Boat system 4**

Instructor-provided information

1. Make and model of boat — ______________________

   ______________________

2. Length of boat — ______________________

   ______________________

3. Intended use of boat — ______________________

   ______________________

   ______________________

---

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model — ______________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ______________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ______________________

   ______________________

   ______________________

6. How will the engine be positioned on the transom?

   Engine position — ______________________

   ______________________

   ______________________

7. What propeller should be used with this engine and boat application?

   Propeller — ______________________

## Assignment Sheet 1

**Part E** **Boat system 5**

Instructor-provided information

1. Make and model of boat — ______________________________

2. Length of boat — ______________________________

3. Intended use of boat — ______________________________

Technician-provided information

1. What engine would you select for this boat and its intended use?

   Engine make and model — ______________________________

2. Is the engine compatible with the U.S. Coast Guard rating label for the boat? Circle the correct answer below.

   Yes No

3. What is the correct mounting height for the engine selected?

   Mounting height — ______________________________

4. Will an extension kit be required for the engine selected? Circle the correct answer below.

   Yes No

5. What mounting hardware will be required for the engine installation?

   Mounting hardware — ______________________________

6. How will the engine be positioned on the transom?

   Engine position — ______________________________

7. What propeller should be used with this engine and boat application?

   Propeller — ______________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Assignment Sheet 2—Determine Specifications and Parts Requirements for Rigging and Accessories for Outboard-Engine Boat Systems

Name ______________________ Date ____________

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| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________________

---

**Introduction**

Accessories do a lot to define the operation of a boat and to please those who use it. They continue to grow in popularity and provide numerous opportunities for technicians in terms of installation and service. Lots of boaters want to have all the latest gadgets. This means that technicians have to be able to install and adjust such accessories, but a good technician is also able to evaluate other requirements. For example, is a larger battery required, should circuit breakers or fuses be installed, what is the impact on the charging system, etc.? This assignment sheet will provide you with practice in evaluating requirements for installation of rigging and accessories.

**Exercise**

**Directions**

Read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems," and Scenario 1 and Scenario 2 on the following pages. Then, using the resources available in your facility, determine the part numbers and specifications requested. Write your answers on the blanks provided with each scenario.

## Assignment Sheet 2

**Part A**

### Scenario 1

A customer wants to equip a 14-foot runabout with a steering system and remote control for the throttle and tilt and trim functions. Working with the materials in your facility, select appropriate equipment to support these functions, and describe how the equipment will be installed.

## Assignment Sheet 2

**Part B** **Scenario 2**

A boat owner wants a digital speedometer installed on her 16-foot ski boat. The boat does not have a pitot system. What equipment would you choose for this? List the equipment to support these functions, and describe how the equipment will be installed.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Assignment Sheet 3—Inspect Outboard-Engine Boat Systems and Rigging

Name ______________________________ Date ______________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________

______________________________

______________________________

**Introduction**

This assignment sheet covers the inspection of outboard-engine boat systems. This is not a detailed inspection of the engine and system specifications but a general assessment of the safety, physical condition, and security of the boat-system components. The inspection includes the condition of the boat hull, support systems, and engine installation. The exact steps for the inspection will depend on the boat material and hull design, types of engine and support systems, and the conditions of these components. Some general aspects of the inspection include

- Cracks, deformities, corrosion, rust, rot, and other defects in the hull.
- Wear, alignment, deformities, corrosion, cable fraying, and other defects in moving parts.
- Secure fastening of the engine, hardware, windshield, top, seats, fuel tank, and other attached components.
- General condition of the overall system.

**Exercise**

**Directions**

First, read Student Supplement 1, "Types of Hulls Used in Outboard-Engine Boat Systems and Their Applications," and Student Supplement 2, "Guidelines for Rigging Outboard-Engine Boat Systems." Next, have your instructor provide you with two outboard-engine boat systems. Then, inspect these boat systems and record your findings by completing the inspection checklists on the following pages.

## Assignment Sheet 3

**Part A** **Boat system 1 inspection checklist**

1. Type of boat hull (displacement or planing) — ______________________

______________________________________________

2. Hull material used (fiberglass, wood, plywood, aluminum, etc.) —

______________________________________________

3. Hull shape (flat, vee, catamaran, etc.) — ______________________

______________________________________________

4. Type of engine (make and model) — ______________________

______________________________________________

5. Application (intended use of boat system—workboat, runabout, sport boat, etc.) — ______________________

______________________________________________

6. Describe the overall condition of the hull. (Any fouling, rot, crazing, etc.?)

______________________________________________

______________________________________________

______________________________________________

7. Describe the overall condition of the rigging. (Any wear, alignment, deformities, corrosion, cable fraying, defects in moving parts?)

______________________________________________

______________________________________________

______________________________________________

______________________________________________

8. Describe the fastening of the engine, hardware, windshield, top, seats, fuel tank, and other attached components.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

## Assignment Sheet 3

9. Describe the general condition of the overall boat system.

10. Identify and describe any boat-system repairs and any other recommendations you would suggest to the boat's owner.

## Assignment Sheet 3

**Part B** **Boat system 2 inspection checklist**

1. Type of boat hull (displacement or planing) — ______________________

______________________________________________

2. Hull material used (fiberglass, wood, plywood, aluminum, etc.) —

______________________________________________

3. Hull shape (flat, vee, catamaran, etc.) — ______________________

______________________________________________

4. Type of engine (make and model) — ______________________

______________________________________________

5. Application (intended use of boat system—workboat, runabout, sport boat, etc.) — ______________________

______________________________________________

6. Describe the overall condition of the hull. (Any fouling, rot, crazing, etc.?)

______________________________________________

______________________________________________

______________________________________________

7. Describe the overall condition of the rigging. (Any wear, alignment, deformities, corrosion, cable fraying, defects in moving parts?)

______________________________________________

______________________________________________

______________________________________________

______________________________________________

8. Describe the fastening of the engine, hardware, windshield, top, seats, fuel tank, and other attached components.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

## Assignment Sheet 3

9. Describe the general condition of the overall boat system.

10. Identify and describe any boat-system repairs and any other recommendations you would suggest to the boat's owner.

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 1—Install and Adjust Outboard Engines

**Introduction**

This job sheet covers the installation and adjustment of outboard engines. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Assemble engine system
- Install engine
- Adjust engine height
- Adjust trim tab
- Adjust controls
- Connect instruments, such as tachometers, temperature gauges, fuel gauges, etc.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting outboard engines and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a boat and an outboard engine to install.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 1

## Worksheet—Install and Adjust Outboard Engines

Name

Attempt number

Date

---

**Part A: Pre-performance check**

Job

- Complete the following information concerning the assigned equipment.

  Equipment brand

  Equipment model/type and code

- Complete the following service-manual information.

  Service-manual title

  Section/page number of procedure

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature**

## Job Sheet 1

## Worksheet—Install and Adjust Outboard Engines

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | |
| Procedures completed correctly. | |
| Proper tools used correctly. | |
| Safety precautions observed. | |
| Service meets specifications. | |
| Clean-up and follow-up actions adequate. | |
| **Overall rating** | |

**Evaluator's comments**

---

## Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 2—Install and Adjust Remote Engine-Control Assemblies

**Introduction**

This job sheet covers the procedure for installing and adjusting remote engine-control assemblies. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions and other reference materials. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Connect control assembly to engine
- Install control box and cabling
- Adjust linkages

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting remote engine-control assemblies and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one control assembly. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a remote engine-control assembly.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 2

## Worksheet—Install and Adjust Remote Engine-Control Assemblies

Name ______________________ Attempt number __________

Date ______________________

---

**Part A:** **Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 2

## Worksheet—Install and Adjust Remote Engine-Control Assemblies

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ______________________________________________

______________________________________________________________

______________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
# Unit 1

## Job Sheet 3—Install and Adjust Steering Systems

**Introduction**

This job sheet covers the procedure to install and adjust steering systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Install steering-input device, such as a steering wheel
- Plan cable routing and install cables
- Connect steering linkages between input device and engine pivot connection, including hydraulic actuators if used
- Adjust steering linkages
- Lubricate gears, linkages, and other moving parts
- Adjust fluid levels for hydraulic systems

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting steering systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one steering system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a boat that requires installation of a steering system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 3

## Worksheet—Install and Adjust Steering Systems

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 3

## Worksheet—Install and Adjust Steering Systems

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________________________

__________________________________________________________________

__________________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 4—Install Tank-to-Engine Fuel Lines

**Introduction**

This job sheet covers the procedures for installing tank-to-engine fuel lines. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Measure and size line lengths
- Route and secure lines
- Connect lines to fuel tank
- Connect lines to engine
- Install filters

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.
2. Watch your instructor's demonstration of installing tank-to-engine fuel lines and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one fuel system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of tank-to-engine fuel lines.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 4

## Worksheet—Install Tank-to-Engine Fuel Lines

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 4

## Worksheet—Install Tank-to-Engine Fuel Lines

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

______________________________________________________________

______________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 5—Install Remote Oil Tanks

**Introduction**

This job sheet covers the procedure for installing remote oil tanks. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Secure tank
- Connect lines to engine and tank
- Verify oil flow

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing remote oil tanks and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a remote oil tank.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 5

## Worksheet—Install Remote Oil Tanks

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 5

## Worksheet—Install Remote Oil Tanks

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 6—Service and Install Batteries

**Introduction** This job sheet covers the procedures for servicing and installing batteries. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Select appropriate battery for application
- Test and charge battery as required
- Adjust battery fluid level
- Install battery
- Connect electrical circuits to battery

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of servicing and installing batteries and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires the installation of a battery.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 6

## Worksheet—Service and Install Batteries

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 6

## Worksheet—Service and Install Batteries

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________________

________________________________________________________________

________________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 7—Install and Adjust Pitot Systems

**Introduction**

This job sheet covers the procedures for installing and adjusting pitot systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Create installation area for pitot tube and system
- Attach pitot tube
- Install transducer and electrical circuits
- Connect pitot system and gauges
- Adjust pitot system

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting pitot systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a pitot system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 7

## Worksheet—Install and Adjust Pitot Systems

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 7

## Worksheet—Install and Adjust Pitot Systems

**Part B:** **Performance evaluation**

**Evaluation criteria** **Rating**

Correct procedures identified for assigned equipment. ______

Procedures completed correctly. ______

Proper tools used correctly. ______

Safety precautions observed. ______

Service meets specifications. ______

Clean-up and follow-up actions adequate. ______

**Overall rating** ______

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 8—Install and Adjust Transducer Systems

**Introduction**

This job sheet covers the procedure for installing and adjusting transducer systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Install sensors, transducers, and instruments
- Install wiring
- Adjust transducer system

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.
2. Watch your instructor's demonstration of installing and adjusting transducer systems and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one transducer system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system that requires the installation of a transducer system.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/ materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 8

## Worksheet—Install and Adjust Transducer Systems

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 8

## Worksheet—Install and Adjust Transducer Systems

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

________________________________________________________________

________________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 9—Install and Adjust Instruments and Gauges

**Introduction**

This job sheet covers the procedures for installing and adjusting instruments and gauges. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Select instruments and gauges
- Prepare boat for installation
- Install instruments and gauges
- Make electrical connections
- Adjust instruments and gauges

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting instruments and gauges and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one type of instrument. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system and instruments for installation.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/ materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 9

## Worksheet—Install and Adjust Instruments and Gauges

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 9

## Worksheet—Install and Adjust Instruments and Gauges

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

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# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 10—Install and Adjust Electrical Accessories

**Introduction**

This job sheet covers the procedures for installing and adjusting electrical accessories. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Prepare boat for installations
- Install electrical accessories
- Install wiring
- Install circuit breakers and fuses
- Install controls
- Make electrical connections
- Adjust electrical accessories

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.
2. Watch your instructor's demonstration of installing and adjusting electrical accessories and any supporting media provided by your instructor.
3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one type of electrical accessory. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.
4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of an electrical accessory.
5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.
6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.
7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 10

## Worksheet—Install and Adjust Electrical Accessories

Name ______________________ Attempt number ________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 10

## Worksheet—Install and Adjust Electrical Accessories

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

# Orientation to Outboard-Engine Boat Systems and Rigging
## Unit 1

### Job Sheet 11—Install and Adjust Hardware Accessories

**Introduction**

This job sheet covers the procedures for installing and adjusting hardware accessories. You will accomplish these tasks by following the appropriate procedures in the manufacturer's installation instructions. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Prepare boat for installation
- Install accessories
- Interconnect accessories to other systems
- Adjust hardware accessories and other systems

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of installing and adjusting hardware accessories and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one hardware accessory. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system that requires installation of a hardware accessory.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 11

## Worksheet—Install and Adjust Hardware Accessories

Name ____________________________ Attempt number _________

Date ____________________________

---

**Part A: Pre-performance check**

Job ________________________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ________________________

  ________________________________________

- Complete the following service-manual information.

  Service-manual title ____________________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ____________________________

## Job Sheet 11

## Worksheet—Install and Adjust Hardware Accessories

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________

______________________________

______________________________

# Trailers and Safe Towing and Boat Operation
## Unit 2

## Objective Sheet

### Unit objective

After completing this unit, the student should be able to identify the major components of trailers used for outboard-engine boat systems; select, maintain, and repair trailers; safely tow trailers and outboard-engine boats; and safely launch, operate, and load outboard-engine boats. The student should demonstrate these competencies by completing the assignment sheets and job sheets and by scoring a minimum of 85 percent on the written test.

### Specific objectives

After completing this unit, the student should be able to

1. Match the major components of trailers used with outboard-engine boat systems to their correct functions.
2. List the design characteristics used to classify trailers.
3. State guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle.
4. Describe the purposes of the trailer bow-stop and tongue-weight adjustments.
5. List types of trailer brake systems.
6. Complete statements about the principles of hydraulic-brake-system operation.
7. Complete statements about the principles of electric-brake-system operation.
8. Complete statements about the principles of surge-brake-system operation.
9. List the typical service procedures required for trailers.
10. Determine trailer specifications and parts requirements. (Assignment Sheet 1)
11. Select trailers for outboard-engine boat systems. (Assignment Sheet 2)
12. Inspect trailers. (Assignment Sheet 3)
13. Complete a boat-safety exam. (Assignment Sheet 4)
14. Perform routine maintenance on trailers. (Job Sheet 1)
15. Repair trailers. (Job Sheet 2)
16. Safely tow outboard-engine boats. (Job Sheet 3)
17. Safely launch outboard-engine boats. (Job Sheet 4)

## Objective Sheet

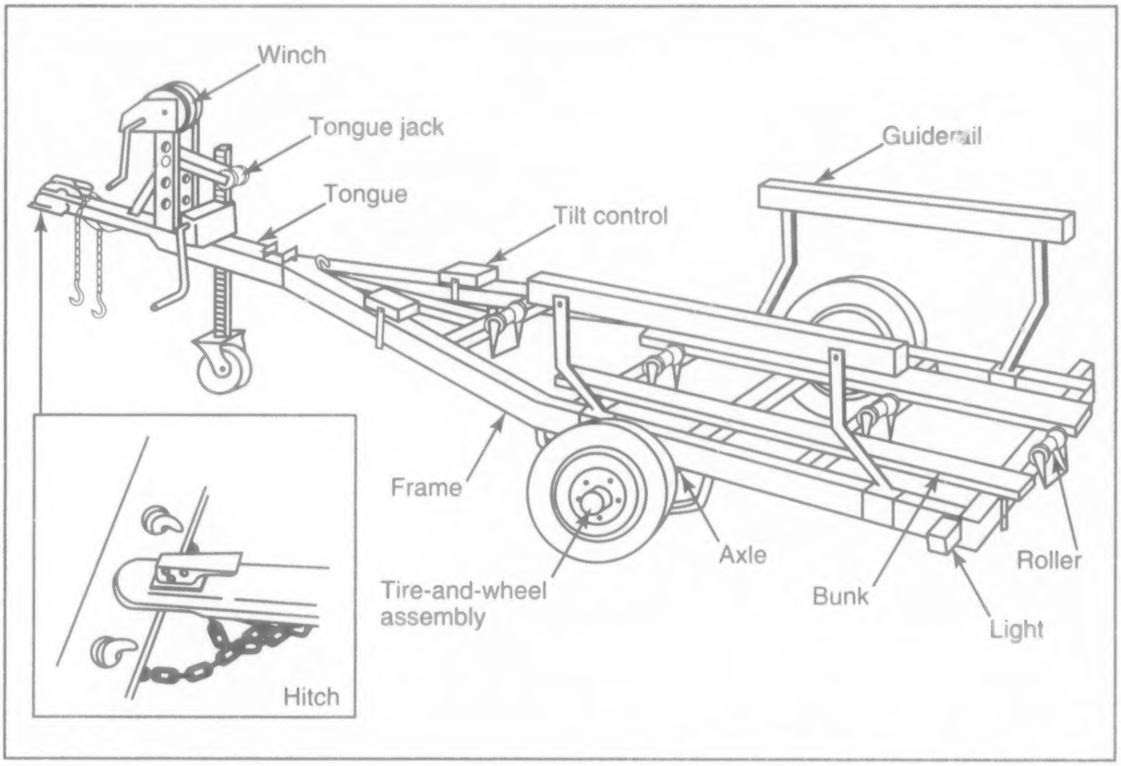
18. Safely operate outboard-engine boats. (Job Sheet 5)
19. Safely load outboard-engine boats. (Job Sheet 6)

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Information Sheet

1. **Major components of trailers used with outboard-engine boat systems and their functions** (see Figure 1)

**Figure 1:** Major components of trailers


Winch
Tongue jack
Tongue
Tilt control
Guiderail
Frame
Tire-and-wheel assembly
Axle
Bunk
Roller
Light
Hitch

- **Hitch**—Fastens the trailer to the tow vehicle
- **Tongue**—Provides an extension from the trailer to the tow vehicle to allow adequate clearance between the tow vehicle and the boat during turns
- **Tongue jack**—Raises and lowers the tongue to position the hitch to the tow-vehicle bumper and to level the trailer during storage
- **Winch**—Provides a mechanism for loading a boat onto its trailer and for lowering the boat from the trailer
- **Frame**—Forms the support framework for the other trailer components

## Information Sheet

- **Boat supports** (bunks, rollers, and guiderails)—Form the support framework for the boat

  Note: Three types of boat supports are used on many trailers—bunks, rollers, and guiderails. Bunks are carpet-covered planks that support the boat hull. Bunks are normally attached to the trailer frame so that they pivot as the position of the boat shifts. Rollers support the boat keel and roll to assist in loading and unloading the boat on the trailer. Some trailers will not have bunks; some will only have rollers; some will have both bunks and rollers. Some trailers also have guiderails to support the sides of the boat.

- **Axle**—Supports the frame and secures the tire-and-wheel assemblies to the trailer

  Note: A trailer may have one, two, three, or more axles. Typically, the frame is mounted to the axle assembly by a suspension system that includes springs and, often, shock absorbers.

- **Tire-and-wheel assembly**—Houses the wheels, wheel bearings, and the brakes

  Note: The parts of the tire-and-wheel assemblies must be serviced regularly for the safe and dependable operation of the trailer. This is especially important because the wheels are frequently submerged while the boat is being loaded and unloaded.

- **Tilt control**—Allows a portion of the boat support to be raised mechanically, electrically, or hydraulically

- **Light system**—Illuminates the trailer to improve its visibility and to provide information to other drivers

  Note: Light systems for trailers usually consist of taillights and brake lights as a minimum, but many trailers may also have other lights such as running lights or license-plate lights.

2. **Design characteristics used to classify trailers**

   Note: While trailers vary in some details such as number of axles, type of hitch, etc., four characteristics are normally used to classify trailer designs: (1) type of boat support used, (2) degree of submersibility, (3) use of tilt control, and (4) load capacity.

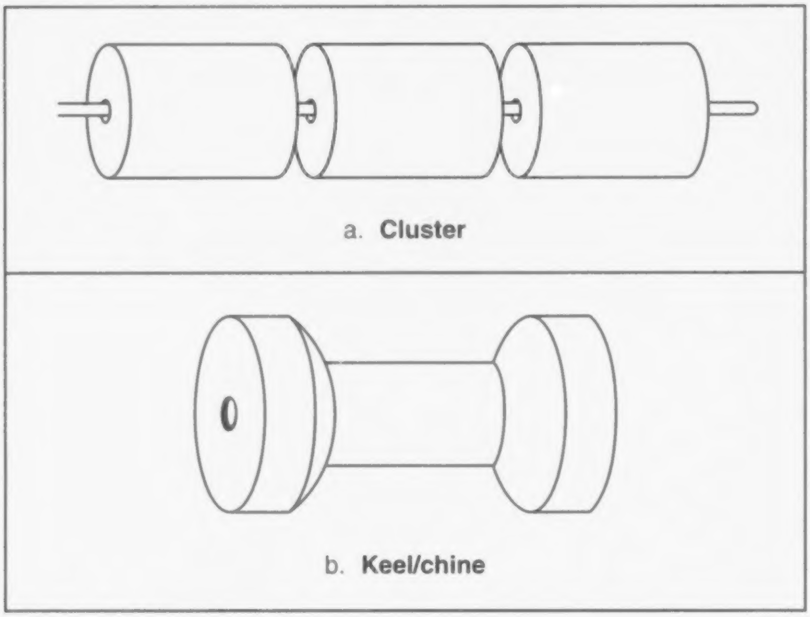
   - **Type of boat support used—rollers or bunks** (see Figure 1 on the previous page)

     Note: The two principal purposes of trailers are (1) to transport boats or (2) to store boats. One basis, then, for selecting a trailer for a particular boat is to decide which will be the primary purpose for the trailer. For example, if a boat will be loaded and unloaded frequently, then a roller design may be desirable; if a boat will be stored for long periods of time, a bunk design may be preferable.

     The two most-common configurations of rollers are cluster and keel/chine (see Figure 2 on the next page). The cluster configuration has rollers scattered over the support area while the keel/chine design provides support for specific hull areas. Roller supports are intended for use with the weight of the boat being supported by the trailer rather than by water. Bunks are normally used for boats under 20 feet in length, and bunk supports are often used with rollers for the keel. Both rollers and bunks can be adjusted to better fit the hull shape of a boat.

## Information Sheet

**Figure 2:** Cluster and keel/chine roller configurations


a. **Cluster**

b. **Keel/chine**

- **Degree of submersibility—submersible or fully submersible**

  Note: All quality boat trailers can tolerate exposure to water, but some can tolerate more exposure than others. Fully submersible trailers are designed so that they can be backed well into the water to launch the boat, and the trailer's electrical system, wheel bearings, metal parts, and other components are specifically protected against damage by water.

- **Use of tilt control**

  Note: Some trailers allow a portion of the boat support to be raised mechanically, electrically, or hydraulically.

- **Load capacity**

  Note: The frame and the suspension system of a trailer are designed to withstand a certain amount of weight safely. By U.S. Coast Guard regulations, each trailer carries a label showing its load capacity.

3. **Guidelines for selecting the proper trailer for an outboard-engine boat system and tow vehicle**

- The trailer must be able to accommodate the weight of the boat.

- The trailer must be able to accommodate the shape and dimensions (length and width) of the boat.

  Example: The length of the trailer must allow the boat to be loaded without excessive overhang.

- The hitch system of the trailer must be compatible with the hitch system on the tow vehicle.

## Information Sheet

### 4. Purposes of the trailer bow-stop and tongue-weight adjustments

Note: Most trailers allow adjustments of the bow stop and tongue weight to accommodate the dimensions and weight distribution of the boat that will be towed.

- **Bow-stop adjustment**—The bow stop provides the forward rest for the boat. The bow stop must be set at the proper height to correctly distribute the balance of the load as the boat is thrust forward on the trailer by the momentum of towing.
- **Tongue-weight adjustment**—The weight of the boat and trailer must be properly balanced at the hitch system between the tow vehicle and the trailer. Excessive weight on the bumper can damage the tow vehicle or cause separation between the tow vehicle and the trailer. Excessive weight on the trailer can cause the trailer to track erratically. The tongue can be lengthened or shortened to change the balance point of the trailer, which changes the amount of weight that rests directly on the bumper of the tow vehicle.

### 5. Types of trailer brake systems

Note: Braking is initiated in the tow vehicle. For many tow vehicles, the weight of the boat and trailer would be too much additional weight for the vehicle's brake system to handle. Consequently, a trailer has its own brake system that works in conjunction with the tow vehicle's brake system.

Because the tow vehicle and the trailer are separate systems, there must be a means of transmitting power from the tow vehicle to the trailer so that the brakes on both can work together. The principal ways of transmitting power to the trailer's brake system are (1) hydraulics, (2) electricity, and (3) momentum.

- **Hydraulic**
- **Electric**
- **Surge**

### 6. Principles of hydraulic-brake-system operation

- Hydraulic pressure is used to actuate the trailer brakes.
- Power for the hydraulic pump is normally provided by an electrical circuit powered by the tow vehicle's electrical system.
- When the tow-vehicle brakes are applied, electricity powers the hydraulic pump to move the brake piston, forcing the brake shoes against the drum.
- When the tow-vehicle brakes are released, power is removed from the hydraulic-piston actuator and a return mechanism, such as a spring, pulls the brake shoes back from the drum.

## Information Sheet

### 7. Principles of electric-brake-system operation

- When the tow-vehicle brakes are applied, an electrical circuit is closed so that the vehicle brake lights come on.
- The trailer lighting harness includes a connection between the tow-vehicle brake-light circuit and an electromagnetic circuit in the trailer brakes.
- When the tow-vehicle brakes are applied, the electromagnet in the trailer-brake circuit is switched on and a solenoid pushes the trailer's brake shoes against the drum.
- When the tow-vehicle brakes are released, the electromagnet in the trailer-brake circuit is switched off and a return mechanism, such as a spring, pulls the trailer's brake shoes back from the drum.

### 8. Principles of surge-brake-system operation

- The tow-vehicle brakes slow the tow vehicle and, thus, the trailer.
- The momentum of the trailer causes the surge brakes to engage.
- When the tow vehicle accelerates, the increase in speed causes the surge brakes to disengage.

### 9. Typical service procedures required for trailers

- **Pack wheel bearings**

  Note: It is particularly important to keep the wheel bearings on boat trailers well lubricated due to the fact that trailers may sit for long periods without use and the wheels are often submerged in water.

- **Replace, repair, or rotate tires**

  Note: Trailer tires are subject to deterioration because they are generally light-duty construction and are frequently submerged in water. They often sit in one position for long periods also.

- **Adjust or replace brake pads**
- **Replace lamps or electrical wiring**

  Note: The taillights on boat trailers often go in and out of the water, which can lead to rust and corrosion.

- **Lubricate mechanical parts such as the hitch or the tongue jack**

  Note: Be sure to use a water-resistant lubricant.

- **Adjust, repair, or replace bunks**
- **Replace rollers**

## Information Sheet

- **Adjust bow stop or tongue weight**

  Note: For proper towing and storage, the boat must sit properly on the trailer. The bow stop helps to balance the boat and keep it from sliding forward. Adjusting the tongue weight allows the positioning of the tongue so that the weight of the boat is properly distributed on the tow-vehicle bumper.

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Student Supplement 1—Guidelines for Outboard-Engine Boat-System Transport and Operation

### Introduction

In addition to servicing boats and engines, the technician is often required to operate outboard-engine boat systems to diagnose problems or to test the performance of the craft after service or modifications. Operating the boat system also involves getting it to the water, which means that the craft must be placed on a trailer, towed to the test site, and launched. This supplement covers guidelines for these associated tasks, including:

- Selecting a trailer
- Towing a boat system
- Launching a boat
- Operating a boat
- Loading a boat

### Guidelines for selecting a trailer

While service technicians will not generally have to make an independent decision about what trailer offers the best match for a given boat, they often have to evaluate which of a limited number of trailers available is best suited for transporting a specific boat system. In many instances, the technician may use the customer's trailer to haul a boat being serviced. In such cases, the service technician should assess the suitability of the owner's trailer for transporting the boat and should advise the customer of any problems in matching the boat and the trailer.

The major consideration in selecting a trailer for a boat is safety—that is, can the boat be adequately secured to the trailer and the trailer be towed without risk of an accident? The first concern is how well the boat and trailer match physically. The primary areas of interest include:

- **Load capacity**. Is the trailer rated to support the weight of the boat system? Remember, the weight of the boat system may be considerably more than the weight of the boat hull alone. In addition to the engine, the hull may be rigged with a fuel tank, steering system, canopy, additional seats, fishing accessories, communications and navigation equipment, and other items that can more than double the weight of the hull alone. Not only must the load capacity of the trailer be adequate to support this weight, but the tires must be the correct size, load capacity, and inflated pressure to accommodate the full load.

  Trailers carry labels, generally on the tongue, that list the load capacity of the trailer. Remember also that boat trailers are designed to carry the boat and its normal accessories but not excessive additional weight in the boat.

- **Length**. The trailer must be long enough so that the front of the boat meets the bow stop without hanging over the rear of the trailer excessively. If the boat protrudes too far beyond the rear of the trailer, a number of problems are likely to develop. There is a danger that the boat is not adequately supported and that the boat may come off the trailer. The rear of the boat may drag the road surface as the tow vehicle passes over dips and rises. If too much weight is to the rear of the trailer axles, the trailer may not follow the tow vehicle properly and may fishtail—weave from side to side.

- **Width**. The trailer must be wide enough so that the sides of the boat do not extend beyond the width of the axle. Specifically, the bunks or other supports must fit the side of the hull snugly to prevent the boat from tottering from side to side and high enough up on the sides of the boat so that the hull is supported against lateral movements.

- **Bottom support**. The trailer must provide support to the bottom of the hull appropriate to the shape of the hull. Specifically, the hull will have one or more keel ridges. Ideally, keel rollers will be provided for each keel. Cluster rollers or bunks should be located at a sufficient number of points along the hull so that the boat is not simply resting on the bow and stern. Also, the rollers and bunks must reduce friction enough to allow the boat to slide on and off the trailer during launching and loading. This means bunks must be properly surfaced and rollers must turn freely.

Other concerns for selecting a trailer include the following.

- **Bow stop**. The bow stop must provide a resting point for the bow that is adjustable to a height near the deckline.

- **Brakes**. If the trailer is equipped with brakes, the system must supplement the braking capacity of the tow vehicle so that the weight of the boat and trailer can be safely stopped.

- **Physical soundness**. The technician should inspect the trailer for physical defects, such as bent or rusted frame components, broken or cracked welds, damaged bunks and rollers, loose or missing hardware, worn hitch, bent or damaged tongue, worn or cracked links in the safety chain, frayed winch cable, bent or damaged axles, broken or "sprung" springs, etc. As noted before, the tires should be properly inflated, but the technician should also ensure that the tires are not excessively worn and that the rims are in good condition.

- **Lighting system**. Besides physically accommodating the boat, the trailer must have a working lighting system, including brake lights, taillights, and turn signals, as a minimum. The technician should ensure that the configuration of the boat and accessories such as boat covers do not obscure the visibility of the lights.

- **Proper match with the tow vehicle**. The trailer and the tow vehicle must be properly matched. The tow vehicle must be powerful enough to pull the loaded trailer at safe speeds. The vehicle must also have the braking capacity required to safely stop the vehicle and load. If the trailer has a brake system, the tow vehicle must be able to power that system. The connection between the trailer and tow-vehicle lighting systems must be compatible. The hitch components of the trailer and the tow vehicle must be of the same design and size. The technician should ensure also that the hitch-mounting hardware is properly secured.

## Guidelines for towing a boat system

- **General guidelines for towing**. Technicians need to know the general guidelines for safe towing because they may have to tow a trailer after performing service on the trailer, or they may have to tow a boat on a trailer to take the boat to a launch site after performing service on the boat system.

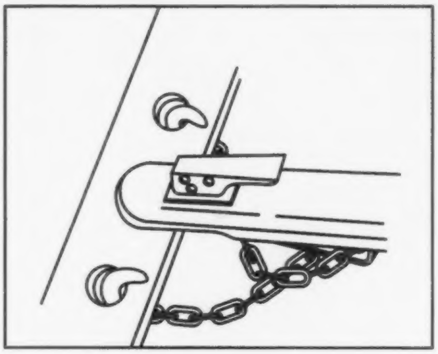
  — Ensure that the tow vehicle is capable of towing the trailer.

  — Ensure that the boat is properly secured to the trailer.

  — Ensure that the trailer is securely hitched to the tow vehicle.

  The tow vehicle must have a secure means of fastening to the trailer, and the trailer must have a secure means of fastening to the tow vehicle. Many systems have safety chains or other devices as added protection in the event that the trailer breaks loose from the tow vehicle (see Figure 1).

**Figure 1:** Safety chains



  — Do not overload the trailer.

  Each trailer has a limited load capacity. The combined weight of the boat and the engine cannot exceed the load capacity of the trailer.

  — Ensure that the lights on the trailer are operable.

  Even if the trailer is not to be operated at night, the brake lights and turn signals are important safety features that must be operable.

  — Ensure that the trailer tires are properly inflated.

  The trailer tires are an important part of the suspension system and are critical to the support of the load. Much of this support is provided by the air pressure in the tires. Under- or overinflated tires overheat and are likely to blow or otherwise fail; they can also cause the trailer to track erratically, especially if the tires on one side of the trailer are drastically different in air pressure.

- Ensure that the trailer tires are not overly worn.
- Ensure that the trailer brake system is properly connected and operable.
- When operating the tow vehicle with the trailer attached, be especially aware of obstructed vision to the rear. Often, extended side mirrors on the tow vehicle may be required.
- Remember, the handling characteristics of the tow vehicle will be affected by the trailer load. The vehicle and trailer combination will require a wider turning radius, and there may be a tendency for the trailer to sway at certain speeds. Most importantly, the distance required to stop the vehicle and loaded trailer will be greater—more than twice as much under some circumstances. Additionally, stopping will be less stable with a greater tendency to deteriorate into a skid.
- Check to ensure that there will be nothing in the path of the trailer when you will be pulling forward or backing.
- Place blocks in front of and behind the wheels of the trailer whenever it is parked.

  Blocks prevent the trailer from rolling or shifting. If the trailer is parked on an incline or even if the trailer is parked on a flat surface, there is a danger that the trailer may be bumped or otherwise moved.
- Make sure that items in the boat are secured before traveling. At moderate speeds, light items such as life preservers and ice-chest lids are likely to blow out. Even at low speeds, fuel tanks, fishing equipment, and other loose items are likely to shift position and may become damaged or may damage other items.

- **General procedure for towing**. Usually, the technician will have no written instructions on how to tow an outboard-engine boat system on a trailer, and the specific procedure used can vary in many ways due to the differences in factors such as the type of boat used, the type of trailer used, the tow vehicle used, road conditions, etc. However, the technician must be familiar with the general towing procedure and then make him- or herself familiar with the specific procedures for a particular tow vehicle, boat, and trailer.

  The following is the general procedure the technician should follow when preparing to tow an outboard-engine boat system.

  1. Inspect the trailer to ensure that the tires are in good condition and properly inflated. Also check the general condition of the trailer, including the frame, weld joints, fasteners, boat supports, etc.

**Student Supplement 1**

2. Make sure the boat is properly loaded and secure on the trailer.

3. Ensure that the trailer wheels are properly blocked and that there are no obstacles between the tow vehicle and the trailer.

4. Ensure that the trailer hitch allows enough height to clear the bumper of the tow vehicle. A common hitch design is the ball-and-cup design in which a cavity in the trailer tongue fits over a ball on the hitch of the tow vehicle. Other designs are used and will affect the procedure for aligning the tow vehicle and trailer.

5. Position a spotter to help you align the tow-vehicle hitch with the trailer.

6. Back the tow vehicle into position to connect the hitch.

7. Set the tow-vehicle parking brake, place the transmission in gear or in park, and turn off the engine.

8. Connect the trailer tongue to the hitch.

9. Fasten the safety chain or other accessories by crisscrossing the chains under the coupler. The hook of the chain should go up under the hitch, and then, the hook should be pointed back toward the trailer (see Figure 1).

10. Install the electrical connection.

11. Remove the wheel blocks.

12. Release the tow-vehicle parking brake and pull the vehicle forward slightly; apply the tow-vehicle brakes. Have the spotter verify that the trailer brake lights work properly.

13. Turn on the tow-vehicle headlights, and have the spotter check to see that the trailer taillights and running lights are working.

14. Test the tow-vehicle left and right turn signals, and have the spotter ensure that the trailer turn signals are operating properly.

15. Place the tow vehicle in reverse and back the trailer a few feet to get a feel for how the trailer backs.

16. Place the tow vehicle in gear or park and turn off the engine.

17. Inspect the trailer hitch and trailer connection to ensure that they are still secure.

18. Return to the tow vehicle and pull forward at low speed. Try to turn to the left and right under controlled conditions to check the trailer's tracking and turning radius and the clearance between the vehicle and boat in a full turn.

19. Continue in a straight line to a speed of about 20 mph and apply the brakes to ensure that the tow vehicle and trailer stop easily.

## Student Supplement 1

### Guidelines for launching a boat

- **General guidelines for launching**. Prior to launching the boat, inspect it to be sure that no damage occurred to the boat or trailer during transport. For example, check the hull to ensure that it has not been cracked or punctured from rocks or road debris. Be sure that the engine is fully tilted and that the drain plug is in place.

  Boats should only be launched from approved ramps. Ensure that the ramp, including the water area, is free of obstacles. Before backing the trailer toward the water, release any holddowns on the boat, disconnect the trailer lights, and attach a towline to the bow and stern of the boat. Have someone hold the towlines and serve as a spotter.

  Use caution when backing the trailer and maintain communication with the spotter. Do not allow the trailer to get too deep in the water and do not allow the tow-vehicle rear wheels or tail pipe to enter the water. The boat should be launched using the bouyancy of the water as much as possible, allowing the boat to slide from the bow stop by letting rope out from the winch.

- **General procedure for launching**. The following is the general procedure the technician should follow when launching an outboard-engine boat system.

  1. Ensure that the launch area is clear of obstacles.
  2. Position the tow vehicle and trailer for the launch.
  3. Position a spotter to assist with the backing process.
  4. Release any hold-downs for the boat.
  5. Attach two towlines (one to the front and one to the rear) of the boat and have another person on shore hold the lines.
  6. Disconnect the trailer lights from the tow vehicle.
  7. Back the tow vehicle and trailer into the water to the point that the boat begins to float.

     Note: Be sure that the drain plugs are installed before backing the boat into the water.

  8. Stop the tow vehicle, place the transmission in gear or park, set the parking brake, and turn off the engine.
  9. Use a wheel block to block the front tire on one side of the tow vehicle.
  10. Release some rope from the trailer winch and slide the boat into the water until the boat clears the trailer.
  11. Board the boat and lower the engine into the water.
  12. Start the engine and ensure that water is flowing through the cooling system.

13. Disconnect the winch rope and move the boat clear of the trailer.

    Note: It may be possible to slide the boat from the trailer with a slight shove or by using the engine.

14. Secure the winch rope.

15. Remove the wheel block from the front tire of the tow vehicle.

16. Drive the tow vehicle forward to move the trailer out of the water.

Once the boat is clear of the trailer, it can be moved from the launch area with the towlines, paddles, or careful, low-speed operation of the engine. The trailer and tow vehicle can then be removed from the launch area and parked.

## Guidelines for operating a boat

Two sets of guidelines apply to the operation of a boat when diagnosing a problem or testing boat performance after service. First, all the general guidelines for safe operation must be observed. Second, the technician must remain aware of the purpose of operating the boat—testing boat performance.

- **General guidelines for operating a boat**. In terms of overall safe boat operation, the technician should become familiar with the boat, the area where the boat is being operated, and the rules of boat operation specific to that area. There are some general rules of safe boat operation, such as those outlined by the U. S. Coast Guard. However, there may be specific restrictions for a particular body of water. For example, on some lakes, it is not permitted to operate a powered boat so as to cause a wake, to operate boats over certain lengths, or to operate powered boats at night. Such operational restrictions may apply to the entire lake or just to portions of it.

  As a minimum, a technician should adhere to the following guidelines:

  - Do not overload the boat.

    A boat can safely support a limited amount of weight without danger of sinking. A technician should not transport passengers unless absolutely necessary. If it is necessary, then the number of passengers and weight capacities must not be exceeded.

  - Observe all speed limits.
  - Observe all restricted-operation areas.
  - Be courteous; if in doubt, yield to other boaters.
  - Ensure that the boat has adequate safety devices, to include life preservers for all passengers.

    Life jackets, belts, and other flotation devices must be available for each person in the boat. The flotation devices should be approved by the U. S. Coast Guard or a comparable regulatory agency.

  - Observe weather conditions and operate the boat only when it is safe to do so.

    If the weather is stormy or if the boat must be operated in high or swiftly running water, do not operate the boat. Operation by a technician is normally for test purposes only, so it should be done only when it can be done safely and when the test results cannot be overly affected by weather or water conditions.

- **General guidelines for testing boat performance**. Special precautions that should be observed when testing a boat include:

  - Remember, you are operating property that belongs to someone else; treat it with care.
  - Be sure that someone knows what your plans are, where you will operate the boat, and when you expect to get back.
  - Be aware of the likely effects of the customer's complaint or the service modification on the boat to avoid overtaxing the boat system's operating limits.
  - Get to know the boat thoroughly.
  - Take along additional safety equipment, such as a fire extinguisher, radio, etc.

### Guidelines for loading a boat

- **General guidelines for loading**. Loading the boat is similar to launching it except the procedure is done in reverse. Most of the same guidelines apply, such as not getting the tow-vehicle wheels in the water. Additionally, the following specific guidelines should be observed.

  - Raise the engine.
  - Do not use engine power to drive the boat onto the trailer.
  - Ensure that the winch rope or cable is secure before pulling the trailer from the water.
  - Once the trailer and boat are clear of the water, park the tow vehicle, placing the transmission in PARK or in gear, setting the parking brake, and cutting off the engine.
  - Secure the boat and inspect it before traveling; be especially careful to check the security of the engine mounting and condition of the transom.

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Assignment Sheet 1—Determine Trailer Specifications and Parts Requirements

Name ______________________________ Date ______________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | _______ |
| Minimum of 85 percent of answers are correct. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

**Introduction**

Outboard-engine technicians are often called upon to service other components of boat systems, including the trailers that are used to transport boats. Trailers have to be matched to the boat in terms of length, load capacity, width, bow stop, braking capacity, etc. Many of the characteristics of a trailer can be adjusted to accommodate a particular boat. In some cases, a trailer may undergo substantial changes, such as different wheel diameters, heavier wheel bearings, a different light system, etc. A technician may be called upon to provide various types of trailer service. In this assignment sheet, you will practice selecting parts and determining specifications for boat trailers.

**Exercise**

**Directions**

For this assignment, your instructor will assign you five trailers to use to complete the exercise. Using the resources available in your facility, determine the part numbers and specifications requested for each trailer. Write your answers on the blanks provided with each item.

## Assignment Sheet 1

**Part A** **Trailer 1**

1. Make and model of trailer — ______________________________
2. Length, width, and load capacity — ______________________________
3. Braking capacity — ______________________________
4. Part number for wheel bearing — ______________________________
5. Size of hitch ball — ______________________________
6. Size of tires and recommended inflation — ______________________________
7. Part number for brake-light bulb — ______________________________
8. Torque value for wheel bearings — ______________________________
9. Part number for brake shoes (or pads) — ______________________________
10. Recommended winch lubricant — ______________________________
11. Other service requirements — ______________________________

## Assignment Sheet 1

**Part B** **Trailer 2**

1. Make and model of trailer — ____________________

2. Length, width, and load capacity — ____________________

3. Braking capacity — ____________________

4. Part number for wheel bearing — ____________________

5. Size of hitch ball — ____________________

6. Size of tires and recommended inflation — ____________________

7. Part number for brake-light bulb — ____________________

8. Torque value for wheel bearings — ____________________

9. Part number for brake shoes (or pads) — ____________________

10. Recommended winch lubricant — ____________________

11. Other service requirements — ____________________

## Assignment Sheet 1

**Part C** **Trailer 3**

1. Make and model of trailer —
2. Length, width, and load capacity —
3. Braking capacity —
4. Part number for wheel bearing —
5. Size of hitch ball —
6. Size of tires and recommended inflation —
7. Part number for brake-light bulb —
8. Torque value for wheel bearings —
9. Part number for brake shoes (or pads) —
10. Recommended winch lubricant —
11. Other service requirements —

## Assignment Sheet 1

**Part D** **Trailer 4**

1. Make and model of trailer — ______________________
2. Length, width, and load capacity — ______________________
3. Braking capacity — ______________________
4. Part number for wheel bearing — ______________________
5. Size of hitch ball — ______________________
6. Size of tires and recommended inflation — ______________________
7. Part number for brake-light bulb — ______________________
8. Torque value for wheel bearings — ______________________
9. Part number for brake shoes (or pads) — ______________________
10. Recommended winch lubricant — ______________________
11. Other service requirements — ______________________

## Assignment Sheet 1

**Part E** **Trailer 5**

1. Make and model of trailer — ____________________
2. Length, width, and load capacity — ____________________
3. Braking capacity — ____________________
4. Part number for wheel bearing — ____________________
5. Size of hitch ball — ____________________
6. Size of tires and recommended inflation — ____________________
7. Part number for brake-light bulb — ____________________
8. Torque value for wheel bearings — ____________________
9. Part number for brake shoes (or pads) — ____________________
10. Recommended winch lubricant — ____________________
11. Other service requirements — ____________________

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Assignment Sheet 2—Select Trailers for Outboard-Engine Boat Systems

Name ______________________________ Date ______________

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| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | _______ |
| Minimum of 85 percent of answers are correct. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** ________________________________________

________________________________________

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**Introduction** Outboard-engine technicians often have to test the results of their work by operating a boat system, especially when the work involves mounting an engine or rigging certain systems. Consequently, the technician must know how to transport the boat to the test area. This generally requires the use of a trailer, which must be properly matched to the boat. Some of the considerations that must be made include the load capacity of the trailer, whether it is the proper length, whether the trailer design is compatible with the hull design, how the boat is to be supported, whether the trailer adjustments (bunks, bow stop, etc.) can provide adequate support, and similar concerns.

**Exercise**

**Directions** Read Student Supplement 1, "Guidelines for Outboard-Engine Boat-System Transport and Operation." Then, your instructor will complete Items 1 through 4 in the "Instructor-provided information" section on the next pages to identify two boat systems for you—each boat system will be either one in your facility or one based on specific boat and engine designs. Your instructor will also identify a selection of three boat trailers—again, either actual trailers in your facility or trailers available in catalogs or dealerships. You will complete the information requested in Item 1 in the "Technician-provided information" section for each boat system. From the three trailers your instructor identifies, choose the trailer best suited for transporting the assigned boat system and then explain your decision.

## Assignment Sheet 2

**Part A** — **Boat-system 1**

Instructor-provided information

1. Boat description: Hull style — ____________________

   Length — ____________________

   Engine make and model — ____________________

2. Trailer 1 —

   Trailer description: Make and model — ____________________

   ____________________

   Length — ____________________

   Bow-stop adjustment — ____________________

   Trailer-weight adjustment — ____________________

3. Trailer 2 —

   Trailer description: Make and model — ____________________

   Length — ____________________

   Bow-stop adjustment — ____________________

   Trailer-weight adjustment — ____________________

4. Trailer 3 —

   Trailer description: Make and model — ____________________

   Length — ____________________

   Bow-stop adjustment — ____________________

   Trailer-weight adjustment — ____________________

Technician-provided information

1. Which of the three trailers described above would you select for the boat system your instructor has described? Explain your reasons for selecting that trailer.

   ____________________

   ____________________

   ____________________

   ____________________

   ____________________

   ____________________

   ____________________

   ____________________

## Assignment Sheet 2

**Part B** **Boat-system 2**

Instructor-provided information

1. Boat description: Hull style — ____

   Length — ____

   Engine make and model — ____

2. Trailer 1 —

   Trailer description: Make and model — ____

   ____

   Length — ____

   Bow-stop adjustment — ____

   Trailer-weight adjustment — ____

3. Trailer 2 —

   Trailer description: Make and model — ____

   Length — ____

   Bow-stop adjustment — ____

   Trailer-weight adjustment — ____

4. Trailer 3 —

   Trailer description: Make and model — ____

   Length — ____

   Bow-stop adjustment — ____

   Trailer-weight adjustment — ____

Technician-provided information

1. Which of the three trailers described above would you select for the boat system your instructor has described? Explain your reasons for selecting that trailer.

   ____

   ____

   ____

   ____

   ____

   ____

   ____

   ____

OEBS-123

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Assignment Sheet 3—Inspect Trailers

Name ______________________________ Date ______________

---

**Evaluation criteria** **Rating**

Directions have been followed. ______

Minimum of 85 percent of answers are correct. ______

**Overall rating** ______

**Evaluator's comments** ______________________________

______________________________

______________________________

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**Introduction**

This assignment sheet covers the inspection of outboard-engine boat trailers. This is a general inspection of the safety, physical condition, security, and general functioning of the trailer. The inspection includes the general condition of the trailer structure, wheel and tire assemblies, lighting systems, and hitch. The exact steps for the inspection will depend on the trailer design and the installed support systems. Some general aspects of the inspection include

- Cracks in weld joints, bent frame components, loose hardware, rust and corrosion, and other defects in the frame and support structure.
- Wear, misalignment, looseness, poor lubrication, and damage to moving parts.
- Defects in electrical, hydraulic, or mechanical subsystems for brakes, lighting, etc.
- General condition of the overall system.

**Exercise**

**Directions**

First, read Student Supplement 1, "Guidelines for Outboard-Engine Boat-System Transport and Operation." Next, have your instructor provide you with two outboard-engine boat-system trailers. Then, inspect these trailers and record your findings by completing the inspection checklists on the following pages.

## Assignment Sheet 3

### Part A Trailer-system 1 inspection checklist

1. Trailer load capacity and length — ______________________

2. Type, size, and condition of hitch — ______________________

3. Describe the condition of the tongue, winch, and tongue jack. (Any cracks, wear, frayed rope or cable, damage, inadequate lubrication, corrosion, load-capacity label missing or not readable, loose or missing hardware, etc.?)

4. Describe the condition of the frame. (Any cracks in weld joints, cracked or bent tubing, loose or missing hardware, etc.?)

5. Describe the condition of the boat support system. (Any missing or worn bunks, rails, or rollers; rollers that will not turn; loose or missing hardware; bow stop or tilt controls that will not adjust, etc.?)

6. Describe the condition of the suspension system. (Any bent or broken springs, worn or leaking shock absorbers, loose or missing hardware, etc.?)

## Assignment Sheet 3

7. Describe the condition of the tire and wheel assemblies. (Any tire wear or poor conditions, improper tire inflation, loose or missing hardware, bearings inadequately lubricated, etc.?)

8. Describe the condition of the brake system. (Any worn pads or shoes, deformed or worn drums or rotors, loose or missing hardware, improper condition or operation of electrical or hydraulic components?)

9. Describe the condition of the lighting system. (Any bulbs not working, improper system operation, loose or missing hardware, broken or damaged lenses, improper wiring condition, etc.?)

10. Identify and describe to the trailer owner any other recommendations you would make regarding the condition of the trailer, its service requirements, and its fitness for service.

## Assignment Sheet 3

**Part B** **Trailer-system 2 inspection checklist**

1. Trailer load capacity and length —

2. Type, size, and condition of hitch —

3. Describe the condition of the tongue, winch, and tongue jack. (Any cracks, wear, frayed rope or cable, damage, inadequate lubrication, corrosion, load-capacity label missing or not readable, loose or missing hardware, etc.?)

4. Describe the condition of the frame. (Any cracks in weld joints, cracked or bent tubing, loose or missing hardware, etc.?)

5. Describe the condition of the boat support system. (Any missing or worn bunks, rails, or rollers; rollers that will not turn; loose or missing hardware; bow stop or tilt controls that will not adjust, etc.?)

6. Describe the condition of the suspension system. (Any bent or broken springs, worn or leaking shock absorbers, loose or missing hardware, etc.?)

## Assignment Sheet 3

7. Describe the condition of the tire and wheel assemblies. (Any tire wear or poor conditions, improper tire inflation, loose or missing hardware. bearings inadequately lubricated, etc.?)

8. Describe the condition of the brake system. (Any worn pads or shoes, deformed or worn drums or rotors, loose or missing hardware, improper condition or operation of electrical or hydraulic components?)

9. Describe the condition of the lighting system. (Any bulbs not working, improper system operation, loose or missing hardware, broken or damaged lenses, improper wiring condition, etc.?)

10. Identify and describe to the trailer owner any other recommendations you would make regarding the condition of the trailer, its service requirements, and its fitness for service.

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Assignment Sheet 4—Complete a Boat-Safety Exam

Name ________________________________ Date ________________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________________

________________________________________________________________

________________________________________________________________

**Introduction**

Many types of power product equipment are hand tools or operator-driven equipment that are not used in public traffic. However, some types of equipment, such as motorcycles and outboard-engine boats, are intended to be operated on public thoroughfares. Operation under these conditions requires a knowledge of how to operate the vehicle and how to operate it safely. Because technicians often have to operate outboard-engine boat systems in order to diagnose problems and to test performance after service, they must be familiar with safe boat-system operation. One commonly used resource material for helping boaters understand boat safety is the U.S. Coast Guard booklet *Federal Requirements and Safety Tips for Recreational Boats*. Other resource materials are provided by your state's boating-law administrating agency.

**Exercise**

**Directions**

Your instructor will provide you with the latest edition of the safety information provided by the U.S. Coast Guard and/or your state's boating-law administrating agency.

Study this information, and then take the sample safety exam in this assignment sheet. Answer each of the following items. Write an "X" in the blank before the correct answer with each test item and then explain your answer and cite the source of your information on the blanks provided below each question.

## Assignment Sheet 4

**Sample safety exam**

1. Where must the registration number of a boat appear on the hull?

_______ a. On the front half of the boat on the left side only

_______ b. On the aft half of the boat on the left side only

_______ c. On the front half of the boat on both sides

_______ d. On the rear half of the boat on both sides

Explain your answer and cite the source of your information on the blanks below.

2. What VHF-FM radio channel is used for emergency transmissions?

_______ a. 13

_______ b. 14

_______ c. 15

_______ d. 16

Explain your answer and cite the source of your information on the blanks below.

## Assignment Sheet 4

3. Which of the following actions would be considered negligent or grossly negligent operation of a vessel?

_______ a. Operating a boat in a swimming area

_______ b. Insufficient fire extinguishers on board

_______ c. Both of the above

_______ d. Neither of the above

Explain your answer and cite the source of your information on the blanks below.

4. If a person dies or receives injuries requiring more than first aid as a result of a boating accident, how soon must a formal report be filed?

_______ a. Within 24 hours

_______ b. Within 48 hours

_______ c. Within one week

_______ d. Any time during that boat-registration year

Explain your answer and cite the source of your information on the blanks below.

## Assignment Sheet 4

5. Which of the following "musts" is **not** a requirement for wearable personal flotation devices (PFDs)?

_______ a. PFDs must be Coast Guard-approved.

_______ b. PFDs must be in good and serviceable condition.

_______ c. PFDs must be of the appropriate size for the intended wearer.

_______ d. PFDs must be protected by storing them in plastic bags and keeping them in closed compartments if they are not worn during operation of the vessel.

Explain your answer and cite the source of your information on the blanks below.

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

6. Which of the following is true with regard to the number of PFDs required when operating a vessel?

_______ a. Boats less than 16 feet in length are not required to carry PFDs.

_______ b. Boats longer than 16 feet are required to have one Type I PFD for each person on board.

_______ c. Boats longer than 16 feet are required to have one Type I PFD *and* one Type IV PFD for each person on board.

_______ d. If a Type V PFD is to be counted toward the minimum carriage requirements, it must be worn.

Explain your answer and cite the source of your information on the blanks below.

________________________________________

________________________________________

________________________________________

________________________________________

________________________________________

## Assignment Sheet 4

7. What color of flag is used for a daytime distress signal?

_______ a. Red

_______ b. Orange

_______ c. Yellow

_______ d. Black

Explain your answer and cite the source of your information on the blanks below.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

8. Technician A says that all outboard-engine boats are required to carry fire extinguishers. Technician B says that outboard-engine boats that have permanently mounted fuel tanks are required to carry fire extinguishers. Who is correct?

_______ a. Technician A

_______ b. Technician B

_______ c. Both Technician A and Technician B

_______ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

______________________________________________

**Assignment Sheet 4**

9. What class of fire extinguisher is recommended for use on boats?

________ a. A

________ b. B

________ c. C

________ d. D

Explain your answer and cite the source of your information on the blanks below.

10. When are boats required to have ventilation systems?

________ a. If they use gasoline to generate electricity

________ b. If they use gasoline to provide mechanical power

________ c. If they use gasoline to propel the boat

________ d. All of the above

Explain your answer and cite the source of your information on the blanks below.

## Assignment Sheet 4

11. Technician A says that all boats over 16 feet in length must have backfire flame-control devices on their engines. Technician B says that boat owners are responsible for ensuring that their boats are properly ventilated. Who is correct?

_______ a. Technician A

_______ b. Technician B

_______ c. Both Technician A and Technician B

_______ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

12. Technician A says that outboard-engine boats must display navigation lights between sunset and sunrise. Technician B says that outboard-engine boats must display navigation lights during periods of reduced visibility, such as heavy fog. Who is correct?

_______ a. Technician A

_______ b. Technician B

_______ c. Both Technician A and Technician B

_______ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

______________________________________________________________

## Assignment Sheet 4

13. With regard to a boat operator's facing forward, what color of navigation light should be used on the left side of the bow?

_______ a. Red

_______ b. Green

_______ c. White

_______ d. None of the above

Explain your answer and cite the source of your information on the blanks below.

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

14. If two vessels are approaching each other head-on, what action should be taken?

_______ a. The vessels should pass each other starboard to starboard.

_______ b. The vessels should pass each other port to port.

_______ c. The vessel nearer to shore should stop and yield to the other vessel.

_______ d. The vessel farther from shore should stop and yield to the other vessel.

Explain your answer and cite the source of your information on the blanks below.

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

## Assignment Sheet 4

15. Technician A says that the person in charge of a vessel is obligated by law to provide assistance that can be safely provided to any individual in danger at sea. Technician B says that the person in charge is subject to a fine and/or imprisonment for failure to do so. Who is correct?

________ a. Technician A

________ b. Technician B

________ c. Both Technician A and Technician B

________ d. Neither Technician A nor Technician B

Explain your answer and cite the source of your information on the blanks below.

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 1—Perform Routine Maintenance on Trailers

**Introduction**

This job sheet covers the routine maintenance associated with trailers. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Inspect components, including mechanical, hydraulic, and electrical components
- Lubricate bearings, hitches, and other moving parts
- Adjust wheel bearings (preload) and brakes
- Adjust bow stop and tongue weight
- Adjust tire pressure

Note: Some routine procedures may not be covered in service manuals. In many cases, you will be able to apply techniques that you have learned with other types of equipment in the maintenance of a trailer. For example, adjusting tire pressure may not be explained in a service manual but is similar to the procedure for lawn and garden equipment.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of performing routine maintenance on trailers and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one trailer. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a trailer.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 1

## Worksheet—Perform Routine Maintenance on Trailers

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 1

## Worksheet—Perform Routine Maintenance on Trailers

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Proper tools used correctly. | ________ |
| Safety precautions observed. | ________ |
| Service meets specifications. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ________________________________________________

________________________________________________________________

________________________________________________________________

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 2—Repair Trailers

**Introduction**

This job sheet covers the procedures associated with repairing trailers. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Replace trailer components, including mechanical, electrical, and hydraulic components
- Overhaul trailer subsystems, including tilt systems, brake systems, electrical systems, etc.
- Perform adjustments to return trailer systems to original operating specifications

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of repairing trailers and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one trailer. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with a trailer that requires repair.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 2

## Worksheet—Repair Trailers

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________

  Equipment model/type and code ______________________

  ______________________

- Complete the following service-manual information.

  Service-manual title ______________________

  Section/page number of procedure ______________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 2

## Worksheet—Repair Trailers

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |

**Overall rating** ______

**Evaluator's comments** ________________________________________

________________________________________________________________

________________________________________________________________

# Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 3—Safely Tow Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely towing outboard-engine boats. There is no specific procedure on how to tow a boat and trailer. The procedure can vary in many ways due to the differences in the boat used, the trailer used, the tow vehicle, road conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the trailer is properly secured to the tow vehicle, and that the lights are connected and working.
- Ensure that the boat is properly secured to the trailer.
- Be aware of the height of the boat compared to the height of the tow vehicle.
- Do not overload past the capacity of the trailer, the hitch, or the tow vehicle.

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely towing outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system and tow vehicle.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 3

## Worksheet—Safely Tow Outboard-Engine Boats

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________________

  Type and size of boat and engine ______________________________

  Type of tow vehicle ______________________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned towing procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 3

## Worksheet—Safely Tow Outboard-Engine Boats

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Procedures completed correctly. | _______ |
| Equipment operated correctly. | _______ |
| Safety precautions observed. | _______ |
| Clean-up and follow-up actions adequate. | _______ |
| **Overall rating** | _______ |

**Evaluator's comments** __________________________________________

____________________________________________________________

____________________________________________________________

# Trailers and Safe Towing and Boat Operation
# Unit 2

## Job Sheet 4—Safely Launch Outboard-Engine Boats

### Introduction

This job sheet covers the procedure for safely backing trailers and launching outboard-engine boats. There is no specific procedure on how to back a trailer and launch a boat. The procedure can vary in many ways due to the differences in the boat used, the trailer used, the tow vehicle, site conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the boat was not damaged during transport.
- Disconnect the trailer lights before backing the trailer into the water.
- Launch the boat only in an approved ramp area.
- Do not allow the trailer to get too low in the water or allow the tow vehicle to enter the water.
- Ensure that the engine is raised or that it will not strike any obstacles or surfaces.
- Ensure that the drain plug is in place.

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

### Procedure

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely launching outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system on a trailer and tow vehicle.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 4

## Worksheet—Safely Launch Outboard-Engine Boats

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ______________________

  Type and size of boat and engine ______________________

  Type of tow vehicle ______________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned launching procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 4

## Worksheet—Safely Launch Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Procedures completed correctly. | ______ |
| Equipment operated correctly. | ______ |
| Safety precautions observed. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

________________________________________________________________

________________________________________________________________

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 5—Safely Operate Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely operating outboard-engine boats. There is no specific procedure on how to safely operate outboard-engine boats. The procedure can vary in many ways due to the differences in the boat used, lake conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the boat has adequate safety devices, including personal flotation devices, operable lights and horns, etc.
- Observe all speed limits and rules of operation specific to the area
- Observe weather conditions
- Operate the boat within its limits

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely operating outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 5

## Worksheet—Safely Operate Outboard-Engine Boats

Name ______________________ Attempt number __________

Date ______________________

---

**Part A: Pre-performance check**

Job ______________________

- Complete the following information concerning the assigned equipment.

  Type and size of boat ______________________

  Type and size of engine ______________________

- Inspect the boat and engine and describe the results of your inspection.

- Describe conditions on the body of water.

- Describe your planned operation procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________

## Job Sheet 5

## Worksheet—Safely Operate Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

**Evaluation criteria** **Rating**

Procedures completed correctly. ______

Equipment operated correctly. ______

Safety precautions observed. ______

Clean-up and follow-up actions adequate. ______

**Overall rating** ______

**Evaluator's comments** ____________________________________________

____________________________________________

____________________________________________

## Trailers and Safe Towing and Boat Operation
## Unit 2

### Job Sheet 6—Safely Load Outboard-Engine Boats

**Introduction**

This job sheet covers the procedure for safely loading outboard-engine boats. There is no specific procedure on how to load a boat on a trailer. The procedure can vary in many ways due to the differences in the boat used, the trailer used, the tow vehicle, site conditions, etc. While the specific procedures will vary, the general tasks that may be performed under this procedure include

- Ensure that the boat and trailer are compatible with one another.
- Do not approach the trailer with the boat under power.
- Ensure that the boat is properly secured before pulling the trailer out of the water.
- Do not allow the trailer to get too low into the water.
- Tilt the engine up before pulling the boat from the water.

Note: This procedure may not be covered in service manuals. Please read Student Supplement 1.

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheets.

2. Watch your instructor's demonstration of safely loading outboard-engine boats and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet more than once. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system and tow vehicle with trailer.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 6

## Worksheet—Safely Load Outboard-Engine Boats

Name ____________________ Attempt number __________

Date ____________________

---

**Part A:** **Pre-performance check**

Job ____________________

- Complete the following information concerning the assigned equipment.

  Type and size of trailer ____________________

  Type and size of boat and engine ____________________

  Type of tow vehicle ____________________

- Inspect the trailer and boat and describe the results of your inspection.

- Inspect the tow vehicle and describe the results of your inspection.

- Describe your planned loading procedure.

- List special equipment/materials required for procedure.

**Instructor's signature** ____________________

## Job Sheet 6

## Worksheet—Safely Load Outboard-Engine Boats

---

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ________ |
| Procedures completed correctly. | ________ |
| Equipment operated correctly. | ________ |
| Safety precautions observed. | ________ |
| Clean-up and follow-up actions adequate. | ________ |
| **Overall rating** | ________ |

**Evaluator's comments** ____________________________________________

____________________________________________________________

____________________________________________________________

# Seasonal Procedures
# Unit 3

## Objective Sheet

**Unit objective**

After completing this unit, the student should be able to describe the purposes of and perform seasonal-service procedures for outboard-engine boat systems. The student should demonstrate these competencies by completing the assignment sheet and job sheets and by scoring a minimum of 85 percent on the written test.

**Specific objectives**

After completing this unit, the student should be able to

1. Define the seasonal procedures required for outboard-engine boat systems.
2. State the purposes of winterizing outboard-engine boat systems.
3. State the purposes of adding stabilizers when winterizing outboard-engine boat systems.
4. Define the term *fogging*.
5. Describe the fogging process.
6. List the typical service procedures required for winterizing outboard-engine boat systems.
7. State the purposes of summerizing outboard-engine boat systems.
8. List the typical service procedures required for summerizing outboard-engine boat systems.
9. Determine seasonal-service specifications for outboard-engine boat systems. (Assignment Sheet 1)
10. Winterize outboard-engine boat systems. (Job Sheet 1)
11. Summerize outboard-engine boat systems. (Job Sheet 2)

## Seasonal Procedures
## Unit 3

### Information Sheet

1. **Seasonal procedures required for outboard-engine boat systems and their definitions**

    - **Winterizing**—Those actions taken to protect a boat system from the effects of exposure to low temperatures and other weather conditions during storage

    - **Summerizing**—Those actions taken to return a boat system to peak operating condition after it has been stored

2. **Purposes of winterizing outboard-engine boat systems**

    Note: There are two aspects of winterizing: (1) protecting the engine and the engine-support systems and (2) protecting the boat's hull. The exact tasks performed during winterizing vary according to the boat system and to the severity of the winter.

    - **To prevent corrosion of engine parts such as piston rings, cylinder walls, and bearing surfaces**

    - **To prevent clogged fuel systems due to varnish and other deposits**

        Note: During storage, gasoline breaks down and can become contaminated with water due to condensation. Some of the by-products of the breakdown of gasoline are varnish and other residues that solidify and can clog fuel lines, carburetor ports, and other openings.

    - **To prevent engine-support-system damage caused by water expansion due to freezing**

        Examples: Water pump and water tube

    - **To keep the battery from discharging**

    - **To reduce boat-system damage due to condensation and low temperatures**

    - **To prevent boat-system damage caused by exposure to the elements**

        Examples: Hull corrosion and cracking, rot, barnacles

3. **Purposes of adding stabilizers when winterizing outboard-engine boat systems**

    - **To delay the breakdown of fuel**

        Note: To reduce the chemical breakdown of gasoline during storage periods, additives can be added to the fuel system. These additives are normally referred to as *stabilizers* or *fuel conditioners*. Typically, one ounce of stabilizer is added to each gallon of fuel to prolong the service life of the fuel for up to one year.

- **To eliminate the need to drain the fuel tank during winterizing**

  Note: If a stabilizing additive is not added to the fuel system, then an alternate procedure is to drain the tank and run the engine until it is out of fuel. While this does prevent the buildup of some deposits, there are several drawbacks to draining the fuel system. Leaving the fuel system dry can lead to deterioration of flexible parts such as hoses and the fuel-pump diaphragm. Running the engine out of fuel—especially two-stroke-cycle engines—can damage the engine. There are also safety and environmental issues: (1) handling fuel is always dangerous and (2) the removed fuel is generally not usable elsewhere and must be disposed of.

### 4. Definition of the term *fogging*

- **Fogging**—Process for coating the internal engine parts to prevent rust and corrosion

### 5. Description of the fogging process

- Operate the engine with the lower unit submerged in clean water to provide adequate cooling.

- Run the engine while injecting rust-preventative oil into the carburetor until the engine smokes excessively.

  Note: If the engine is equipped with fuel injectors, the oil should be sprayed into the vapor separator tank.

### 6. Typical service procedures required for winterizing outboard-engine boat systems

- Add stabilizer or drain fuel system
- Add rust-preventative oil to engine through fogging
- Remove portable fuel tank
- Disconnect spark-plug lead
- Remove and store battery
- Clean and lubricate propeller shaft
- Change lower-unit lubricant
- Touch up paint and finishes
- Apply protective finish to external surfaces

  Example: Marine-grade wax

- Cover or store boat

## Information Sheet

7. **Purposes of summerizing outboard-engine boat systems**

- To undo the steps taken to prepare the boat system for storage
- To restore the engine and boat to peak operating performance
- To prepare the trailer for safe highway operation and secure transport of the boat

8. **Typical service procedures required for summerizing outboard-engine boat systems**

- Check lubricant and other fluid levels
- Check for fluid leaks
- Check battery
- Check engine operation
- Check warning systems
- Check lights and running lights on boat and trailer
- Check trailer tire pressure

# Seasonal Procedures
## Unit 3

### Assignment Sheet 1—Determine Seasonal-Service Specifications for Outboard-Engine Boat Systems

Name ______________________ Date ______________

| **Evaluation criteria** | **Rating** |
|---|---|
| Directions have been followed. | ______ |
| Minimum of 85 percent of answers are correct. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ____________________________________________

**Introduction**

While there are some general principles of seasonal service that are basic to most boat systems, details such as the types of lubricants and protective finishes to use vary with different systems. Specifications for spark plugs, idle speeds, tension adjustments, and other factors differ for different engines and applications. In order to provide proper seasonal storage, a technician must be able to determine the correct specifications for the service. In this assignment sheet, you will practice determining specifications for equipment that may be required for seasonal service.

**Exercise**

**Directions**

Your instructor will fill out Items 1 through 3 in the "Instructor-provided information" section for Parts A through E of this assignment. You will use the resources available in your facility to complete Items 1 through 5 in the "Technician-provided information" section to determine the winterizing and summerizing specifications for each outboard-engine boat system your instructor has identified. Write your answers on the blanks provided with each item.

## Assignment Sheet 1

**Part A** **Boat-system 1**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

Make —

Model —

Type —

2. What is the make, length, and load capacity of the trailer?

Make —

Length —

Capacity —

3. What is the make, model, and type of engine?

Make —

Model —

Type —

Technician-provided information

1. Describe the overall winterizing process.

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

3. Describe the summerizing process.

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

5. What service should be performed on the trailer?

## Assignment Sheet 1

**Part B** **Boat-system 2**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

   Make — ____________________

   Model — ____________________

   Type — ____________________

2. What is the make, length, and load capacity of the trailer?

   Make — ____________________

   Length — ____________________

   Capacity — ____________________

3. What is the make, model, and type of engine?

   Make — ____________________

   Model — ____________________

   Type — ____________________

---

Technician-provided information

1. Describe the overall winterizing process.

   ____________________

   ____________________

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

   ____________________

   ____________________

3. Describe the summerizing process.

   ____________________

   ____________________

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

   ____________________

   ____________________

5. What service should be performed on the trailer?

   ____________________

   ____________________

## Assignment Sheet 1

### Part C Boat-system 3

Instructor-provided information

1. What is the make, model, and type of boat assigned?

Make —

Model —

Type —

2. What is the make, length, and load capacity of the trailer?

Make —

Length —

Capacity —

3. What is the make, model, and type of engine?

Make —

Model —

Type —

Technician-provided information

1. Describe the overall winterizing process.

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

3. Describe the summerizing process.

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

5. What service should be performed on the trailer?

## Assignment Sheet 1

### Part D

### Boat-system 4

**Instructor-provided information**

1. What is the make, model, and type of boat assigned?

   Make — ______________________

   Model — ______________________

   Type — ______________________

2. What is the make, length, and load capacity of the trailer?

   Make — ______________________

   Length — ______________________

   Capacity — ______________________

3. What is the make, model, and type of engine?

   Make — ______________________

   Model — ______________________

   Type — ______________________

**Technician-provided information**

1. Describe the overall winterizing process.

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

3. Describe the summerizing process.

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

5. What service should be performed on the trailer?

## Assignment Sheet 1

**Part E** **Boat-system 5**

Instructor-provided information

1. What is the make, model, and type of boat assigned?

   Make — ______________________________

   Model — ______________________________

   Type — ______________________________

2. What is the make, length, and load capacity of the trailer?

   Make — ______________________________

   Length — ______________________________

   Capacity — ______________________________

3. What is the make, model, and type of engine?

   Make — ______________________________

   Model — ______________________________

   Type — ______________________________

Technician-provided information

1. Describe the overall winterizing process.

   ______________________________

   ______________________________

2. Does the boat system have any accessories or subsystems other than the engine and hull that require winterizing service? If so, what are those accessories or components and what service is required?

   ______________________________

   ______________________________

3. Describe the summerizing process.

   ______________________________

   ______________________________

4. Does the boat system have any accessories or subsystems other than the engine and hull that require summerizing service? If so, what are those accessories or components and what service is required?

   ______________________________

   ______________________________

5. What service should be performed on the trailer?

   ______________________________

   ______________________________

## Seasonal Procedures
## Unit 3

### Job Sheet 1—Winterize Outboard-Engine Boat Systems

**Introduction** This job sheet covers the procedure for winterizing outboard-engine boat systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Stabilize fuel or drain fuel system
- Fog engine
- Remove and inspect portable fuel tank
- Drain water from the engine
- Disconnect spark-plug lead
- Perform visual inspection of boat system
- Remove and store battery
- Drain and lubricate lower unit
- Touch up paint and finishes
- Apply protective finishes to external surfaces
- Cover or store boat

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheet.

2. Watch your instructor's demonstration of winterizing outboard-engine boat systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system to winterize.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 1

## Worksheet—Winterize Outboard-Engine Boat Systems

Name ____________________________________ Attempt number __________

Date ____________________________________

---

**Part A: Pre-performance check**

Job ________________________________________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ____________________________________________

  Equipment model/type and code ____________________________________

  ____________________________________________________________

- Complete the following service-manual information.

  Service-manual title __________________________________________

  Section/page number of procedure __________________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ____________________________________________

## Job Sheet 1

## Worksheet—Winterize Outboard-Engine Boat Systems

---

**Part B: Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ________________________________________

________________________________________________________

________________________________________________________

# Seasonal Procedures
# Unit 3

## Job Sheet 2—Summerize Outboard-Engine Boat Systems

**Introduction**

This job sheet covers the procedures for summerizing outboard-engine boat systems. You will accomplish these tasks by following the appropriate procedures in the manufacturer's service manual. While the specific procedures will depend on the equipment design and manufacturer's processes, the general tasks that may be performed under this procedure include

- Inspect boat and trailer
- Replace spark plugs
- Check lubricant and fluid levels
- Test and charge battery, as necessary
- Check operation of fuel system
- Check operation of thermostat and cooling system
- Check warning systems
- Perform adjustments to return equipment to original specifications

**Procedure**

1. Study the objectives in the information sheet and complete the assignment sheet.

2. Watch your instructor's demonstration of summerizing outboard-engine boat systems and any supporting media provided by your instructor.

3. Review the following worksheet associated with this job sheet. You may be required to accomplish this job sheet for more than one outboard-engine boat system. Check with your instructor, and obtain a copy of the worksheet for each attempt that will be required.

4. Ask your instructor to provide you with an outboard-engine boat system to summerize.

5. Complete the pre-performance check (Part A) on the worksheet and receive your instructor's signed approval for the service information you have located and the equipment/materials you have listed for performing the procedure on the equipment assigned.

6. Review the evaluation criteria listed in the performance evaluation (Part B) on the worksheet.

7. Using the instructor-approved service information and equipment/materials list, perform the appropriate procedure. Your instructor will rate your performance using the evaluation criteria listed in the performance evaluation on the worksheet.

## Job Sheet 2

## Worksheet—Summerize Outboard-Engine Boat Systems

Name ______________________________ Attempt number __________

Date ______________________________

---

**Part A: Pre-performance check**

Job ______________________________

- Complete the following information concerning the assigned equipment.

  Equipment brand ______________________________

  Equipment model/type and code ______________________________

  ______________________________

- Complete the following service-manual information.

  Service-manual title ______________________________

  Section/page number of procedure ______________________________

- List type and number of replacement parts.

- List special equipment/materials required for procedure.

**Instructor's signature** ______________________________

## Job Sheet 2

## Worksheet—Summerize Outboard-Engine Boat Systems

**Part B:** **Performance evaluation**

| **Evaluation criteria** | **Rating** |
|---|---|
| Correct procedures identified for assigned equipment. | ______ |
| Procedures completed correctly. | ______ |
| Proper tools used correctly. | ______ |
| Safety precautions observed. | ______ |
| Service meets specifications. | ______ |
| Clean-up and follow-up actions adequate. | ______ |
| **Overall rating** | ______ |

**Evaluator's comments** ______________________________________________

# Power Product Equipment Technician Series

## Theory and Principles of Engine Operation

Section A: Orientation

Section B: Basic Engine Theory and Operation

## Engine Systems and Service

Section A: Engine Systems

Section B: Engine Overhaul

## Equipment Systems

## Construction Equipment

## Lawn and Garden Equipment

## Outboard-Engine Systems and Service

## Outboard-Engine Boat Systems

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